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VOL. 104 MARCH, 1932 No. 3

EDITORIAL

ANTONJ VAN LEEUWENHOEK—1632

"Whenever I am in doubt or question what I see—I say so. Many cannot understand my writings and frankly say they do not believe me. I console myself because I try to discover facts only—as soon as I find that I have made a mistake I am always willing to admit it."—ANTONJ VAN LEEUWENHOEK.

SOMEWHERE in my readings I happened upon a description of the unimpressive, simple grave of the Dutchman, Antonj van Leeuwenhoek, draper of Delft—drab dealer in homespun and remnants. And one would hardly expect much of a headstone to memorialize so homely a trade as that of a simple seller of cloth. But Van Leeuwenhoek was more than a draper, more than a judge of good fabric; he was a grinder of lenses—a meticulous, masterly grinder of lenses. That was his happy hobby.

While moths grew redolent and fat on his rolls of homespun and irate customers failed to find him home, Van Leeuwenhoek kept to his avocation. His daily grind was a joy and his daily joy a grind. Lenses more perfect than ever before, and assembled more sensibly than ever before—such were his constant aims, and such at last his accomplishments. His was the eternal glory of building the first compound microscope, and his, too, the pioneer joy of seeing what man had never seen before—the first meandering microbe.

Scraping a bit of tartar from his ill-kept teeth and smearing it on a thick glass slide, he looked through his telltale assembly of lenses and actually saw the Lilliputian creatures squirming in his mouth-dirt —the first "bacteria" ever seen by mortal eye.

Out of his many discoveries eventually grew the great science of bacteriology—and it might be safely said that Pasteur and Koch, Lister and Spallanzani, and a blessed host of other benefactors of the human

race—gained from his initial find not just their inspiration but much of their glorious achievement as well.

Van Leeuwenhoek was an epoch maker—a real pioneer who blazed the trail to a most fertile territory. Yet, strange to relate, in the humble little town of Delft, the last resting place of this great minister of science, is marked with but a simple stone, and in unkind contrast to the towering monument of another native son—a generalissimo of a sort in the Dutch army, whose right to be remembered is based on the fact that he was a splendid wielder of the battle axe and greatly gifted in the art and science of wholesale slaughter.

Such travesties on proportional values are monumental mistakes, and if those responsible for such, gave greater glamor to scientists and less to the so-called grandeur of gore and war, human destinies might be changed. The true history of the race, the real progress of civilization, are not matters of generals and guns.

Mankind has not been lifted to the eminences nor its future established by blood on the tip of a bayonet or by bullets that found their lodgment.

No, indeed; it is the march of the men of the microscope, and the toil of the test-tube troopers that will carry mankind on to victory—to victory in the greatest of all conflicts, the fight against disease.

Ask any American schoolboy for a list of the six great warriors of the world and ages, and he will probably say, with some variations, Alexander and Hannibal—Cæsar and Napoleon—and probably Pershing and Foch.

How funny!! and how sad!! But what a responsibility for historians to shoulder—the hysterical historians who have glorified gore and sanctified the sword! !

How much better were it for schoolboys to know that the warriors and saviors of mankind have been men like Pasteur—humble son of the humbler tanner of Arbois, whose genius lifted burdens of pain from the shoulders of suffering humanity—and in whose honor and memory, doorsteps, the world over, carry their early morning, unwitting little white monuments of milk.

Men like Koch, discoverer of the tubercle bacillus; Roentgen, of the inquisitive ray; Scheele, the tireless apothecary of Stockholm, whose chemical discoveries were made under great difficulties; Harvey, pioneer in circulation; Jenner, arch-enemy of smallpox—and countless

other warriors in science—these are the men that have made real history.

These are the men whose names should be familiar to every schoolboy.

The vapid victories of generals and guns fade into insignificance beside the glory of achievement of such men as these.

Hasten the day when they shall have their fair appraisal, and when the memories of their victories shall be an inspiration to the youth of all earth.

IVOR GRIFFITH.

THE CAP AND GOWN IN PHARMACY

GIVING some reminiscences of pharmacy, a recent writer compares the past with the present-day commencement in the colleges of pharmacy. A few years ago, he recalls, at the end of the course the graduates assembled in the class room and the professor said: "This ends the session. Those who have passed the examination will receive their certificates by mail." And it was all over. This was quite a contrast to the graduation days in other lands and in bygone centuries.

As far back as the Middle Ages the apothecary attained the doctor's degree at the university. This required from six to eight years' attendance. The graduation days were portentous in length and pomp. There were thesis readings and disputations. A week or more was occupied with religious ceremonies and solemn discourses, set off by innumerable dinners, suppers and banquets (wine and beer galore). There were games, dances, ballets and horseplay. The candidate had the square cap placed upon his head, accompanied by the sign of the cross, and the "tap." In some instances the apothecary acquired the right to carry a sword and wear a peculiar cape. In those days, when the apothecary walked the streets, his attire elevated him to a place of dignity and respect. Men raised their hats as he passed by and gave to him the right of way.

Within a generation there has been a change in the character of our pharmacy college commencements. This has been a swing from the former simplicity back toward the old world customs. We now have alumni reunions, ball games, dances, dinners—with Volstead beer and unfermented wines—nite clubs, pageants and plays. There are processions, bands, pretty girls and jeweled matrons. The graduates are showered with presents and floral emblems. There are addresses, speeches, music and ceremonial presentation of the candidates for degrees and honor and diploma awards. The stage is filled with tier upon tier of members of the graduating class, in cap and gown, and the members of the faculty and officials are arrayed in gorgeous robes. This is all to the good. For a few days, at least, pharmacy, occupies the centre of the stage.

While it is only in comparatively recent years that the cap and gown has become a feature of the college of pharmacy commencements, the symbol of the gown goes back to the monkish and alchemistic days. In some of the old prints delineating pharmacy in mediæ-

val times, we find the apothecary clothed in cap and gown. It was the clothing of the monks and the alchemists from which the academic gown of today was patterned. The cowl was the forerunner of the hood; the ecclesiastical or academic cap predates the mortar-board.

The hood, the gown and the mortar-board have significance and meaning. Their color stands for something—white for arts and letters; scarlet for theology; blue for law; dark blue for philosophy; golden yellow for science; brown for fine arts; pink for music; green for medicine and olive green for pharmacy.

Some years ago American authorities standardized the colors and the garments. The ordinary student gown—the first to be worn—is of black serge, with pointed sleeves; the Master's gown is of simple black, with sleeves cut as pointed pennants hanging from the elbows; the Doctorate gown is of silk, with facing of the University color. The hood is lined with the official color of the institution, edged with the color of the faculty in which the degree is granted—for example, olive green for pharmacy.

It might be well for pharmacy if more use were made of the cap and gown. They are now seen for only a few hours at commencement time. Perhaps their use should be extended to all great days in college life, such as the opening of the year, on anniversary days, etc. Indeed, it might not be amiss if on the occasion of any stated address by a noted pharmacist, the faculty and the speaker should don the cap and gown. It might be helpful to the cause of education if in our Association meetings a session could be given over to pharmaceutical education, and the college faculties and graduates should be expected to appear at this session in the robes of pharmacy.

In these days the pharmacist is endeavoring to exalt pharmacy. The codes recite the fact that pharmacy is a profession. It is proclaimed that "your druggist is more than a merchant." The cap and gown, strikingly symbolic of this claim convey its truth impressively, colorfully, picturesquely, in no uncertain language. In the store and shop there are occasions, such as the opening of a new store, pharmacy days, and other times, when the graduates serving in the store could appropriately don the cap and gown.

Why not? An old world slogan runs: "Hang your banners on the outer wall." Another one says: "Keep pharmacy to the front." Let us not hesitate on proper occasions to wear our colors and to display the cap and gown.

FRED B. KILMER.

ORIGINAL ARTICLES

NOTES ON THE BEHAVIOR AND IDENTIFICATION OF ARECOLIN, AND ITS USE AS A TÆNICIDE. WITH SOME COMPARISONS WITH PELLETIERIN.

By Charles D. Howard*

ARECOLIN, the medicinally active alkaloid of the areca (betel) nut, and to which this drug owes its vermicidal qualities, occurs in the latter to the extent of 0.07 to 0.10 per cent. The hydrobromide, which is the salt commercially obtainable, has been in vogue in recent years as a remedy for tapeworm, for which purpose it is said to be exceptionally effective. Its use is however largely confined to veterinary practice, where it is employed chiefly as an eliminant of tapeworm in dogs and as a remedy for colic.

Recently the writer had occasion to analyze a proprietary remedy put out for dogs. The very small size of the tablets pointed to an exceptionally potent vermifuge, and these were found to consist of one-eighth grain arecolin hydrobromide. The instructions indicated that active purgation should occur within twenty minutes, and an advantage claimed for the remedy was that fasting is unnecessary. Unlike many vermifuges, arecolin destroys the worm directly through the toxic action exerted. No auxiliary purgation is required, because the drug is itself an active purgative.

Another drug likely to be encountered in the analysis of commercial tapeworm destroyers involving comparatively small dosages is pelletierin, an alkaloid contained in pomegranate bark. While differentiation from arecolin need entail no difficulty or confusion as to pelletierin tannate, the only commercial salt and the one in practice solely used for this purpose at the present time, yet such other salts as the hydrobromide and sulphate are to be found in some chemical lists, and there is considerable similarity in both the chemical behavior and physiological action of the two alkaloids. The dosage of pelletierin salts is however several times larger than is true of arecolin, and it is much less toxic.

Thus Krasnow,[1] following study of the subject, suggests that the dosage of arecolin hydrobromide for dogs should be about 1.6 mg.

*Chemist, New Hampshire Board of Health.

[1] *J. Comp. Path. Therap.*, 37, 246-259 (1924).

per kilogram weight. Merck,[2] however, gives but 1 to 5 mgs. for dogs and 4 to 6 mgs. for man as an anthelmintic,—the first considerably less than was found contained in the proprietary here referred to. Parke, Davis lists tablets of one-eighth grain (8 mg.) as suitable for "small dogs," and suggests that one-fourth grain may be necessary for large ones. The dosage of pelletierin tannate for dogs is given by Merck as 0.3 to 0.4 gram (*i. e.,* about five grains).

According to various authorities, arecolin in overdose gives rise to convulsive attacks, which are followed by paralysis of the central nervous system. There is respiratory and cardiac depression, and the convulsions may be tetanic. A very characteristic property of arecolin is its power to cause contraction of the pupil of the eye. As a myotic its action is said to be even stronger than that of pilocarpin. This property, in conjunction with its volatile character, is suggested by Autenrieth and Warren [3] as affording a means for its identification. According to Sollman,[4] pelletierin also produces myosis, but other authorities mention merely a "disturbance of vision." In other respects the physiological effects of pelletierin are very similar to those of arecolin, with the important distinction, as cited, of much greater toxicity of the latter.

Parties submitting the proprietary for investigation claimed that administration of a single tablet to a "small" kitten had caused its death in convulsions "a few minutes" thereafter. In order to gain some corroborative evidence concerning the toxicity of this preparation one of the one-eighth grain tablets was dissolved in a small quantity of water and given by mouth to a guinea-pig of 350 grams. In five minutes there was noticeable paralysis of the rear limbs, the animal dragging these and tending to move backward in his cage. Although noticeably affected for about a half hour, the paralysis symptoms thereafter commenced to abate and the animal quickly recovered, the only other manifestation being some bloody discharge from the rectum. A second pig of the same weight was then given the equivalent of one and one-fourth tablets (10 mg.). As in the first case, paralysis of the rear extremities, with the peculiar "backing up," was in evidence within five minutes, but thereafter this condition abated and there was apparent recovery. However, in about four hours there was a marked recurrence of the paralysis condition, and in five hours

[2] *Merck's Index,* 1930.
[3] Authenrieth and Warren: "Detection of Poisons" (1928), pp. 373-376.
[4] Sollman: "Textbook of Pharmacology" (1914), p. 745.

the animal was dead. Subsequently two more experiments were conducted with guinea-pigs, each of two being given by mouth aqueous solutions representing 10 mg. pure arecolin hydrobromide. Precisely the same manifestations were noted as in the second case, both animals dying in about five hours following administration of the drug.

Arecolin base is described as a colorless and odorless oily liquid having a strongly alkaline reaction and soluble in all proportions in water, alcohol, ether and chloroform. It boils at 220° and is readily volatile with steam. It forms white definitely crystalline salts, the hydrobromide being as anhydrous needle-shaped prisms or plates melting at 167°-168°. These salts are readily soluble in water and alcohol, less readily in chloroform. The writer finds, however, that the latter, warm, exerts a substantial solvent action upon the hydrobromide, it being easily possible in this way to obtain complete extraction of this compound from an admixture with other substances. The evaporated residues from chloroform and alcohol, at first white and beautifully crystalline, tend to become brownish, with separation of oily drops, on prolonged exposure to the temperature of boiling water.

The following behavior with alkaloidal precipitants was noted:

Potassium bismuthous iodide. Affords a crimson to garnet red precipitate in faintly acidulated solutions. A distinct turbidity is given by both alkaloids in 1-20,000. With this test and the two following, the degree of acidity is important. The tests should be but slightly acidified, using very dilute hydrochloric acid.

Iodine in potassium iodide (*Wagner's reagent*). This is next in sensitiveness, the limit being about 1-5000 for arecolin and 1-10,000 for pelletierin.

Potassium mercuric iodide (*Mayer's reagent*). Not a sensitive precipitant for these alkaloids, the limits being 1-200 for arecolin and 1-1000 + for pelletierin.

Phosphomolybdic acid. Arecolin gives a greenish-white precipitate in 1-1000 solution.

Picric acid. No precipitate with arecolin in moderately dilute solutions. A 1-100 solution affords a slight turbidity. With pelletierin the limit is about 1-1000. According to Autenrieth and Warren [5] the picrate of this alkaloid is especially characteristic, affording well-defined crystals which melt at 150°.

[5] *Loc. cit.*

Mercuric chloride, platinic chloride, auric chloride, tannic acid, lead acetate and lead subacetate. None of these reagents afford precipitates with either alkaloid in moderately dilute solution.

Watts' Dictionary of Chemistry states that pelletierin gives an intense green color with H_2SO_4 and $K_2Cr_2O_7$. The same color is also found to be afforded by arecolin. A few minutes are required for development. The color with arecolin persists undiminished for a day or more.

C. Reichard [6] states that arecolin gives with potassium ferrocyanide in aqueous solution a blue color changing after a few hours to green, and with potassium ferrocyanide a green color. A good method of applying this test was found to be to moderately acidulate the mixture with hydrochloric acid and heat in watch glasses on a water bath. With the ferrocyanide a bright fluorescent bluish-green soon develops, the color of the evaporated residue being striking. Unfortunately, pelletierin was found to afford similar colors, such as not to permit of distinguishing from arecolin. The tests given by Reichard involving potassium cyanide and picric acid, and with cobalt nitrate, failed of confirmation. The first was found to give the reaction with the reagents alone.

Both the free alkaloid and the hydrobromide, in water solution, are odorless and tasteless. The taste of the dry salt is no more than slightly saline and possibly very faintly bitter. It can therefore be stated that as to both odor and taste this substance is characterless.

In the above-named respects pelletierin affords the following comparisons with arecolin. Free pelletierin is a colorless oil boiling at 195° and readily volatile with steam,—but with decomposition, as it absorbs oxygen and tends to turn brown from resinification. Unlike arecolin the free base was observed as exhibiting a slight yet distinct aromatic odor, which latter has been described as suggestive of coniin. This odor is not however very noticeable in the presence of minute quantities of the alkaloid. Such salts of pelletierin as the hydrobromide, hydrochloride and sulphate are said to be obtainable as white crystals. They are however described by Merck as occurring in noncrystalline brown masses, odorless and tasteless. The only salts of pelletierin the writer was able to find on the market following some little inquiry were the sulphate and the tannate, the first being as a syrupy brown mass. The tannate, the form used medicinally, is a

[6] *Pharm. Zentralhall,* 52, 711-716.

light yellow or grayish amorphous powder having the astringent taste and affording the tannin tests due to the acid radicle.

The study here reported involves observation of various color and precipitation tests as applied to arecolin hydrobromide and pelletierin sulphate. Search of the literature reveals but little bearing upon these features. Acccording to Autenrieth and Warren,[7] neither arecolin nor pelletierin gives any characteristic color tests. These and other investigators suggest that the best methods of identification are the melting point determination, volatility with steam, and demonstration of the myotic effect.

For the distillation the "micro" steam distillation apparatus as developed by Hortvet for volatile acids in wine was found to be well adapted. Working with small quantities of the alkaloid, the procedure as suggested by Autenrieth and Warren,[8] rendering alkaline with sodium hydroxide, was found to be worthless, no trace of arecolin alkaloid being recoverable using even the slightest possible excess of this alkali. Approximately quantitative recoveries with arecolin were however found to be obtainable by rendering faintly alkaline to phenolphthalein using lime water, the completion of the distillation being best determined by testing portions of the distillate, faintly acidified, with potassium bismuthous iodide reagent, the latter being found to be by far the most sensitive precipitant for both this alkaloid and for pelletierin. The alkaloids thus volatilized can be fixed and concentrated by evaporation of the distillate with a slight excess of hydrochloric acid.

A characteristic of pelletierin alkaloid is that even highly dilute solutions fume distinctly in contact with hydrochloric acid.

Neither alkaloid gives any color with H_2SO_4 and HNO_3. According to the National Dispensatory (1916), pelletierin gives with H_2SO_4 and selenous acid a light bluish-green color changing to dark green. The writer was unable to obtain such a color test. In his hands this reagent afforded a deep rose color with pelletierin, the tint being light rose with traces. On heating, the color deepens and eventually does change to a dirty olive green. The rose color seems to be quite distinctive for pelletierin and affords a means of differentiation from arecolin, the color afforded with this alkaloid being bright yellow-orange, or bright yellow in the presence of traces. There should be no difficulty in distinguishing the two alkaloids by this test.

[7] *Loc. cit.*
[8] *Loc. cit.*

It will therefore be noted that the two alkaloids are remarkably similar in their chemical characteristics. In medicinal preparations which may contain one of these, clues to identity are afforded by (1) the much smaller dosage of arecolin; (2) the fact that this is commonly present as the hydrobromide, whereas the tannate is the salt of pelletierin usually encountered; (3) the odor of pelletierin base on distillation, both alkaloids being readily volatile with steam; (4) the melting points of certain salts of these alkaloids (arecolin hydrobromide and pelletierin picrate); (5) the readier and more distinctive crystallization of arecolin salts from alcohol and chloroform; (6) the failure of picric acid to precipitate arecolin in dilute solution; (7) the strikingly different color reactions afforded by H_2SO_4 and selenous acid; (8) the marked myotic action afforded by arecolin, any such produced by pelletierin being in much slighter degree.

COWS' MILK AND HUMAN MILK*

By Louis Gershenfeld, Ph. M., B. Sc., P. D.

Professor of Bacteriology and Hygiene, Philadelphia College of Pharmacy and Science

What Is Milk?

Milk is the secretion of the mammary glands of female mammals that suckle their young, and it is produced primarily for the nourishment of the latter. It is a yellowish white, homogenous and opaque liquid, possessing no viscidity, almost odorless, of a characteristic soft and sweetish taste, denser than water and containing in complete or true solution the lactose or sugar, mineral salts and vitamins B and C; in less complete solution or partly in solution and partly in suspension (or colloidal suspension) the albumins, the calcium, magnesium and inorganic phosphate; and entirely in suspension or colloidal solution, vitamin A, casein and fat, the globules of the latter forming the fine emulsion. The white color is imparted to the milk partly through the fine emulsion of the fat and partly through the medium of the casein (ogen) in solution.

Louis Gershenfeld, Ph. M., B. Sc., P. D.

Milk as a Food

If we define a food as a substance satisfying in whole or in part the demand of the body for maintenance of form, building up tissue and supplying energy, then we must admit that milk is indeed a remarkable food. It has been termed by some as the most nearly perfect food and by others as the elixir of life. It is the most satisfactory individual food material produced by nature. Milk is the only product elaborated by living animals as a food and employed solely for this purpose. Milk is the only substance elaborated by nature which contains lactose (sugar of milk) and casein (milk protein); and it is the only animal food consumed by civilized people in the raw state and in such large quantities. Raw milk is the only natural product which has not been altered or modified and which is employed in such large quantities as food without

*One of a Series of Popular Science Lectures given at the Philadelphia College of Pharmacy and Science, 1931 Season.

boiling, cooking or other treatment just as it was used five thousand years ago.

During the first few months of life, milk is practically the sole food of the infant. It is the chief food of every baby and should be the chief food of every child. Milk presenting in itself as it does the proper proportion and variety of material needed for the nourishment of the body during the period when development is progressing with its maximum of activity should be used more freely as an essential part of the diet of boys and girls, if we expect the latter to become the healthy men and women of the future. It is needed by adults, young and old. Its presence more frequently in one's daily rations will contribute greatly to a safe and sane program of health.

Fat in Milk

Milk is not a single, simple, uniform substance like water. It looks as though it were "all one piece," but you will find that on standing for a short time, or if the sample is centrifugalized, milk separates, without coagulating, into two tolerably distinct layers. The lower layer is known as the "skim milk." The latter, corresponding roughly to what constitutes the "milk plasma," contains the sugar (lactose), proteins, mineral salts and some of the vitamins. The upper stratum, a yellowish white and very opaque liquid, known as the cream, contains the large proportion of milk fat, being present in the form of fat globules of varying size, which may be from 1/25000 of an inch to 1/1500 inch in diameter. The size depends frequently upon the breed of cow and the period of lactation. A teaspoonful of milk will contain billions of fat globules. The latter is the most variable constituent of milk and accordingly the cream layer will vary in volume. By churning this cream (or the milk), the fat particles are caused to adhere together into a compact mass, inclosing a small portion of the casein, yielding the product we know as butter. The butter from the milk of different animals varies in appearance, as for instance, human butter is much softer than that from the milk of other animals. In different butters there are also developed certain odorous principles which are more or less characteristic of the animal from which the butter is taken. All milk fats, concentrated fuel foods and therefore a concentrated source of energy, are composed of essentially the same constituents, although in different proportions. The composition is extremely complex. Butter fat contains a larger variety of glycerides (combinations of glycerin and acids) than any other fat. In addition

to palmitin and olein and which it contains in large quantities (almost 75 per cent.), there is also present some stearin (approximately 2 per cent.), these three constituents (known also as the "base" fats or the non-volatile fats) being present in most fats. The remainder of its composition is made up of another non-volatile fat, myristin, and of the glycerides of a number of volatile fatty acids, these fats being peculiar to milk. Chief among them are butyrin, laurin, caproin, caprin and caprylin, which by exposure to light and air decompose readily into their respective fatty acids—myristic, butyric, lauric, caproic, capric and caprylic acids. The production of the latter give the peculiar odor and flavor accompanying the rancidity of butter.

The Proteids of Milk The proteins in milk are of value for the formation of body tissues and fluids and as a body fuel. Inasmuch as milk proteins are capable of maintaining adults and providing for the normal growth of the young when used as the sole protein food, they are at times known as complete proteins. These protein compounds appear to be identical in all varieties of milk, varying only in their relative proportions. Casein is by far the most important of the nitrogenous constituents of milk, and it supplies nearly all of this kind of nutritive matter demanded by the child. Nearly 80 per cent. of the entire proteids of milk is casein. The latter is a phosphorous containing protein (phosphoprotein), and as a salt it exists in cow's milk probably as the neutral calcium caseinate, and in human milk mainly as potassium caseinate. An important amino acid present in almost all proteids is prolin. The casein of cow's and goat's milk has prolin in the molecule, but it has not been found in the casein of human milk. The existing combination of casein is diffused throughout the milk in a somewhat colloidal form, being however so finely divided that in fresh milk it is impossible to separate it by filtration. More recent researches in dairy chemistry reveal that casein is in reality a mixture of several proteins, which are distinguishable from each other. Casein does not coagulate upon prolonged boiling, but is coagulated by nearly all acids. The milk curdling enzymes of the gastric and pancreatic juices have the power of splitting the casein of the milk into soluble paracasein and probably a peptone-like body. The former combines with the soluble calcium salts in the milk producing an insoluble curd of paracasein. The casein is thus reduced from an apparent liquid condition to a semi-solid state. The clear fluid surrounding this curd is known as whey. It is of interest to

note that there is no definite uniformity between American and English scientists when referring to casein and its by-products, when curdling is produced. The English workers call the principal protein of milk caseinogen and the insoluble curd which forms as casein. The American and German scientists refer to the principal milk protein as casein, and the term paracasein is given to the product produced by the action of rennin upon the latter.

Lactalbumin, a soluble proteid resembling serum albumin or egg albumin, and lacto-globulin resembling serum globulin in its general properties are also present in milk. The latter is of little physiological interest. Both are coagulable proteins (coagulated by heat, but not by acids or rennin), lacto-globulin being present only in traces and lactalbumin forming almost 15 per cent. of the milk proteins. Lactalbumin is more abundant in human milk than in goat's and cow's milk.

Casein itself in the diet, as the *only* protein, will not support or aid normal growth to any great extent. The presence of a definite quantity of other varieties of proteins renders normal growth possible. Of all these varieties of proteins investigated thus far, lactalbumin has been the most efficient for the support of growth and also for the correction of deficiencies in other proteins. Its occurrence in milk is therefore to be noted, and the increased use of this product for the growing child is of special significance. Traces of mucoid proteid are also present. Proteins are essential food constituents, being of value for the building of flesh and providing of growth, for the repair of waste and to produce energy.

Milk Sugar

The principal carbohydrate of milk (or nutrient which also supplies energy to the body) is lactose or sugar of milk. It is a specific product of the cellular activity of the mammary gland and is not derived from the blood. Lactose is present normally in the human body only in milk. It may occasionally be found in the urine of individuals, who may have taken into their systems excessive large quantities of lactose, or in women during pregnancy or during nursing. During the curdling of the milk the lactose remains in solution in the whey. Due to bacterial action, lactose in milk ferments, producing dextrose and galactose, which in turn are changed in the main into lactic acid and some alcohol.

Other Nitrogenous Substances

Non-protein nitrogen, especially as is found in urea, uric acid, creatinine, amino acids and ammonia salts is present in all milks. There are also to be found important non-nitrogenous substances of an unknown character, and

it is of interest to note that of all varieties of milk, human milk contains the greater quantity of these substances.

Inorganic Constituents or Mineral Matter of Milk

Lime, phosphorous and iron are the important inorganic constituents in milk. Other elements of minor importance present are sodium, potassium magnesium, chlorine, iodine and sulphur in addition to gases (generally absorbed from the air during milking), like carbon dioxide, nitrogen and oxygen.

Milk furnishes the largest supply of calcium, more than is found distributed in other foods. Weight for weight, it contains twice as much calcium as is present in eggs and turnips, five times as much as is found in white flour, ten times as much as is found in white potatoes, and thirty times as much as is obtainable from beef. An adequate calcium supply in the body must be assured from food. This is especially needed by the growing young for the framework of the body, as the bones and the teeth are composed of large quantities of calcium as well as phosphorous, which is also present in milk. Food calcium obtained from sources other than milk is less readily utilized than milk calcium. Milk carries lime in an especially useful form. Physiological disturbances or nutritional deficiencies leading to a faulty utilization of the calcium which the dietary affords, or insufficiency of lime in the diet results in the actual withdrawal of calcium from the body, a condition which, when it becomes sufficiently acute to cause softening and bending of the bones, is known as osteomalacia.

Phosphorous is another extremely important element in the economy of the body. Foods rich in phosphorous do not necessarily cause retention of this element in the system. This is however not the case of milk which supplies phosphorous in a form that is readily utilized and retained. It must be remembered that the calcium and phosphorous contents of the different varieties of milk vary. Cow's milk contains almost five times and goat's milk six times as much calcium and phosphorous as is found in human milk. An intake of at least one quart of market milk a day will insure the growing child the proper share of calcium and phosphorous which is needed.

Iron occurs in the coloring present in the red blood corpuscles. This element is present in milk in relatively small quantities associated with organic substances. It is on account of this low iron content and the absence or deficiency of one or two desirable vitamins

that makes it impossible to speak of milk as the ideal or perfect food. In the average diet of the child and adult, there must be included beef and muscle meats, eggs, whole cereals, legumes or leafy vegetables if iron in proper amounts is to be supplied to the human body. It is of interest to note that in the unborn child (fetus), iron is supplied by the mother and stored by the child in the liver, bone-marrow and spleen, from which it is withdrawn immediately after birth as long as the child is on a milk diet. More iron seems to be stored in the organs of the fetus than is necessary, but the breast-fed or milk-fed child loses more of this iron reserve than it takes in, unless the infant is given during the later months of its first year, prunes, spinach, eggs, cereals, etc. As is, human milk contains more than twice as much iron as is to be found in cow's milk.

It is to be noted that the inorganic constituents of milk have not been studied in such detail as have the organic substances present. Recently, however, Wright of Scotland and Papish of Cornell University in this country conducted spectrographic analyses of the ash constituent of fresh samples of milk collected in clean glass bottles from cows in various parts of the United States and in Great Britain. These samples revealed small but definite traces of other elements as copper, zinc, aluminum, manganese, silicon, boron, lithium, strontium, titanium and vanadium. The workers mentioned reported that in some cases the quantity of an element present in the milk may be directly influenced by its concentration in the soil where the cows are pasturing. More recently, Grendel (in Pharm. Weekblad) reported the amount of copper in cow's milk is 0.11 mgm., in goat's milk 0.15 mgm., and in human milk 0.22-0.28 mgm. per liter (approximately one quart) of sample. Here again we are led to believe that the addition of copper in suitable form and quantity to the diet is of value and desired. Perhaps this may account for the value of the iron in human milk and comparable to the work of Dr. Hart at the University of Wisconsin, who has found that copper in combination with iron (cupriferrum) is far superior to iron alone in nutritional anemia. It is also of interest to note that the copper content in human milk as compared with cow's milk compares with the respective iron contents, being present to an extent of more than twice as much in human milk as in cow's milk.

Milk Pigments

The yellow color is due partly to lactochrome and partly to milk fat. The pigment of the fat of cow's milk is composed principally of carotin and some xanthophylls, pig-

ments closely related to the chlorophyll of plants. These two substances in equal proportions make up the pigment of the fat of human milk. Carotin, which is widely distributed in plants, is the pigment of human fat and the principal pigment in the body fat and blood serum of the cow.

Enzymes Enzymes (as lipase, amylase, catalase, galactase, oxidases, reductases, lactokinase and perodidases) have been found in milk, but not all of them in milk of the same species of animal.

Vitamins Vitamins or "accessory food substances" are substances of unknown chemical composition. Their action has however been carefully studied and they are found exerting a normalizing influence upon nutrition, maintenance, and growth. They are necessary for growth in the young and for the health and well being of adults. Our knowledge of these agents is as yet very incomplete, though we do know that when one or more of these essential vitamins is lacking or deficient in our diet, various disorders develop in the body, producing the so-called "deficiency diseases." When the vitamin intake is too low, the body resistance is below normal, so that infections have a better opportunity to get the upper hand. The "deficiency diseases" include: 1. ophthalmia or xerophthalmia due to a lack of vitamin A. This vitamin is also known as fat-soluble A (on account of its solubility in fats); antixerophthalmic vitamin; misnamed—antirachitic vitamin; growth-promoting vitamin. Absence or a deficiency of this vitamin causes cessation of growth and an eye affection known as xerophthalmia or ophthalmia. Liberal supplies of this vitamin are needed for tissue formation and healthy development.

2. Beri-beri due to lack of vitamin B. This is also known as water-soluble vitamin; water-soluble B; antineuritic vitamin; growth-promoting vitamin. This, the first vitamin to be discovered is also essential for growth; it stimulates the appetite and its absence or a deficiency in amount produces nervous lesions, polyneuritis in animals and beri-beri in humans.

3. Scurvy due to lack of vitamin C. This vitamin is also known as antiscorbutic vitamin and water-soluble C vitamin. Its presence in the diet in proper quantity prevents scurvy (scorbutis) or cures this if already established.

4. Rickets due to lack of vitamin D. This is known also as "X" of McCollum or "antirachitic vitamin." It is soluble in fats and is at times associated with vitamin A.

5. Sterility disease due to lack of vitamin E. This is also known as Vitamin X of Mattil, Reproductive Vitamin, Funk's Vitamin D, Vitamin E of Barnett Sure, etc.

6. Pellagra due to lack of vitamin G known also as "factor P-P." Pellagra is classed as a deficiency disease and the "P-P factor" must be accorded a place among the vitamins, and designated as suggested as vitamin G. It may be that what was known previously as "Vitamin B" is made up of two fractions, one B 1 possessing the power to prevent or cure polyneuritis or beri-beri and the other, B 2, exhibiting growth-promoting potency which is identical with the "P-P factor." The latter antipellagric factor is referred to as vitamin G by American investigators and as vitamin B 2 by English workers. The antineuritic factor is known as B 1 by the latter, but merely designated as "vitamin B" by Americans.

Milk and milk products do not contain the "P-P factor" or vitamin G. They contain but a minimal amount, an extremely small quantity of vitamin E. Milk and certain of its products contain vitamin D, and due to the antirachitic potency of these substances, the latter are of value to prevent the onset of or cure rickets. It is true that quicker results are obtainable by the administration of cod liver oil or through the production of the antirachitic factor by ultra-violet irradition, but the antirachitic value of milk and certain milk products has been fully established and should not be ignored.

Milk, human and animal, has a high vitamin C content if it is fresh and raw. Vitamin C is not produced by the body or stored in appreciable amounts therein. Its presence depends upon the food taken into the system. Vitamin deficiency by the nursing mother or of the lactating animal as the case may be will mean such deficiency in the milk of the suckling young or the animal milk which may be marketed as a food. Feeding food rich in vitamin C to the mother or animal will result in this being utilized in the enrichment of the content of this vitamin in the milk. Pasteurized milk which in the case of animal milk is preferred to the product because of the assurance that the former preparation is free of disease-producing bacteria has a variable yet reasonably fair content of vitamin C, as the temperature to which the milk is heated destroys a considerable portion

of this vitamin. The proper dietetic procedure is to employ pasteurized milk if animal milk is to be used and to obtain the antiscorbutic protection from other sources, especially tomatoes, and orange juice, as animal milk is not always an absolute source of vitamin C.

Though yeast is the leading source of vitamin B and the whole grains of most all cereals have an abundant supply of it, all milks (raw and pasteurized) and their products contain this vitamin in high concentration. The outstanding source of vitamin A is cod liver oil, but the other most important source is milk, cream, butter and their preparations. Vitamin A is found in greater concentration in milk and its products than is vitamin B. It has however been shown that milk and milk products obtained from cows on green pasturage or those eating leafy food are higher in vitamin A content than these same products produced at seasons of the year when the animals cannot pasture in fields of grass, etc. The vitamins in milk are in the main obtained from the cow's body which stored them from the leafy portion in its feed, though more recently it has been shown that some vitamins, especially vitamin A, may be elaborated by the cow from the yellow coloring matter, carotin, present in some foods. Vegetable oils, as a class, are notably deficient in vitamins A and B. Butter substitutes (margarins) made from these oils have a low vitamin value and are not recommended for their vitamin content, unless the specific preparation has been proven to have a high vitamin concentration due to the addition of other substances. Because of the vitamin content of milk and the protection which is afforded by the latter against the diseases as mentioned, milk is regarded as a protective food. Eggs and the leafy vegetables are the other important protective foods. The latter must however supplement other foods in a properly constituted dietary regime.

Digestion of Milk Milk is one of the foods digested in the stomach with greatest ease. Its highly nutritive properties and the variety of its nutritious constituents render it most valuable as an article of diet. This gives milk an important place in the diet especially of the undernourished and sick, and in particular in those in whom the digestive powers are impaired. In these instances, it is important to supply the system with considerable nutriment without taxing the digestive organs to any marked degree. The ease with which milk is digested depends upon the variety of milk; its condition,

purity and composition; whether raw or heated; admixture with other foods; the physical and mental condition and in few instances the idiosyncracy of the individual.

Milk, a liquid food, is changed when it reaches the stomach. As mentioned under casein, an insoluble curd is produced by the milk-curdling enzymes of the gastric and later by the pancreatic juice. The acid and pepsin in the gastric juice make some of this curd soluble and the remainder is digested in the intestines. The casein of human milk differs from the casein of cow's milk in being more difficult to precipitate or separate by acid or coagulate by the rennin in the gastric juice. The human casein curd (paracasein) forms in a much looser and a more flocculent manner than that from cow's milk, and accordingly it is more readily digested than the latter. Frequently, lime water or barley water is added to cow's milk or varieties of milk other than human milk used for feeding infants, children and invalids, so as to prevent the formation of a tough curd. Experimentation has also revealed that milk is digested more completely when it is taken with other simple foods and present in a mixed diet, for the curd developing under these conditions is not so lumpy and therefore more easily digested. This does not apply to infants on breast milk, as the latter, best adapted to their use, is readily digested.

The fat of milk is more readily emulsified and digested in the intestinal tract than other fats, and therefore this is the fat best suited for infants, children and invalids. On the whole we find that milk not only contains the three essential food requirements protein, fat and carbohydrate, but it contains these food essentials in a readily digestible state as those who digest milk assimilate at least 98 per cent. of the albumins and 99 per cent. or more of the fats and carbohydrate.

Milk in Our Diet and for Under-Nourishment

The proper adjustment of the daily food to the individual and family needs is an important problem. The character of the foods eaten in different parts of the world vary greatly. But in these modern days in civilized countries they are so arranged in our diet for humans other than infants under one year of age as to supply:

(a) a sufficient quantity and quality of energy-producing palatable foods, containing adequate utilizable and easily digested proteins or albumins, fats and carbohydrates;

(b) a sufficient quantity of water to act as a carrier and solvent;

(c) a liberal amount of minerals, especially lime, phosphorous, and iron;

(d) a satisfactory supply of all vitamins; and

(e) bland, neutral, indigestible material, yielding a residue and spoken of as roughage.

Judged by these requirements, milk is an excellent food to be included in one's daily ration. Milk is palatable, completely and readily digestible, supplies all requirements as listed in (a) and (b), and many of those as specified in (c) and (d). It of course lacks some iron, vitamins and cellulose or material comprising the roughage. Milk though a liquid contains more actual nutritive materials than do many of the "solid" foods, and it is the best food available to balance the daily nutritional requirements. The only satisfactory and safe diet for man is a well-apportioned, balanced one, employing cereals; green, leafy vegetables; fruits, eggs and other foods high in protein content; and milk and its products. The latter should be stressed for they are omitted entirely too frequently. Because it cannot be chewed like bread or meat, many regard milk merely as a beverage. This is an erroneous belief. There is no question of the greater food value of milk as compared with any other individual solid food, and where the latter is employed due to individual desires, or a variety of foodstuffs is used to satisfy one's palate, milk and its products are especially valuable in supplementing such diets frequently deficient in various elements.

Mammary Glands The mammary glands in the female species are remarkable organs, not only on account of the valuable secretion which they produce and which is unlike the product of any of the other glands, but their size and structure and changes which they undergo at different periods are peculiar to themselves. It is the only organ in the human and animal body which during life is capable of supplying a product (milk), of value and employed by an individual or animal other than the one supplying it. With the exception of water and inorganic matter, all of the important and characteristic constituents of the milk are formed in the substances of the mammary glands. It is here where the lactose or sugar of milk, the casein or the peculiar protein of milk and the milk fat are produced. None of these substances pre-exist in the blood. Glucose or

grape sugar, cane sugar or saccharose and other sugars present in the blood are never found in milk. These other varieties of sugar are not eliminated by the mammary gland, and do not seem to influence the lactose content of the milk. Casein is produced in the mammary glands, and it is believed that it is formed by a peculiar transformation of the proteid constituents of the blood. The peculiar kind of fat that is present in milk is not found in the blood. It is produced in the substance of the mammary gland, but the exact mechanism of the production of fat in the latter is not definitely known.

Quantity of Milk in Humans

When lactation is fully established, the quality and quantity of the milk secreted become adapted to the requirements of the child at different periods of its existence. As a rule the mother is capable of supplying all the nutritive requirements of the infant for from eight to twenty months, and usually from ten to twelve months among western people, but among eastern people, lactation may continue as high as two and even three years. The secretion of the milk is however markedly affected by violent mental emotions, and is somewhat influenced by the food and liquids taken by the mother and by other physiological factors (especially nervous and mental affections). The quantity of milk available at each nursing and the average quantity secreted by the human female in twenty-four hours varies in different individuals and depends upon the period and progress of lactation. The author has been successful in obtaining as much as 75 c. c. (2½ fluid ounces) from a full breast during the early months after delivery. It is generally assumed that the usual twenty-four-hour output is from one-half pint to one and one-half pints in the early months, and from one to one and a half quarts in the late months of nursing.

Colostrum

The first liquid secreted by the mammary glands of all humans and animals immediately after delivery is so different from ordinary milk that it has been called by another name. It is known as colostrum, and though it resembles perfectly formed milk, it differs from the latter in many respects. Colostrum or beestings, another name given to this product, is secreted for a short time before delivery and during the very early period of lactation or for several days after the birth of the young. It appears at first as a somewhat thick stringy liquid and later as a yellowish, semi-opaque liquid, somewhat mucilaginous or oily in consistency and possessing a pungent odor. In composition, colostrum presents many

points of difference from true milk. It contains more solid matter and more inorganic salts than ordinary milk, but the most striking difference in colostrum is the presence of a high percentage of albumin other than casein. This albumin (specifically globulin) appears to be identical with the albumin (specifically euglobulin) present in the liquid portion of the blood (blood plasma). The globulin in colostrum immediately after birth may be present to as high a percentage as 16 per cent. of the total albumin present, and this becomes reduced gradually in quantity to a 1 per cent. content, and casein takes its place as the secretion of normal milk becomes established. It seems that colostrum furnishes this protein to the blood of the infant, as the blood of the latter at birth is very low in such globulin fraction. It is with this protein or globulin fraction that the protective antibodies or immune agents are associated, and on this account colostrum tends to produce an immunity to disease in the newborn. This special and high protein content is responsible for the coagulation of colostrum upon boiling.

For the same reason colostrum ordinarily decomposes more readily than milk and rapidly takes on putrefactive changes. The peculiar constitution of colostrum renders it somewhat laxative in its effects, and it is supposed to be useful during the first few days after delivery in assisting to relieve the infant of the accumulation of fecal matter. Even on microscopical examination, differences may be observed in the appearance of colostrum and that of milk, but usually following the first week after delivery in the case of cow's milk and after the second or third week in the case of human milk, the peculiar colostrum corpuscles (which are characteristic of this secretion and observed microscopically) disappear. The secretion of milk becomes fully established and the microscopical and chemical characters of the latter obtained from normal humans or normal animals do not reveal any marked constant variations of sufficient importance to lead to the view that the milk from normal humans or animals varies to any great extent during the ordinary periods of lactation. The consensus of opinion prevails that infants and young animals are benefited by colostrum from their own mothers; and humans though benefited by colostrum of human milk should not indulge in the colostrum of milk from other animals. Accordingly, market milk from cows, goats or other animals is free from colostrum; in fact the sale of animal milk containing colostrum is generally pro-

hibited by law. The definition of market milk as generally given is "as the whole, fresh, clean, lacteal secretion obtained by the complete milking of one or more healthy cows, properly fed and kept, excluding that obtained within fifteen days before and five days after calving, or such longer period as may be necessary to render the milk practically colostrum free; which contains not less than 8½ per cent. solids not fat and not less than 3¼ per cent. milk fat."

Human Milk

Animals and infants develop best on milk of their own kind than on milk of foreign species. Accordingly, the human baby is best served by the milk of its own mother if she is in normal health. No imitation can equal breast milk in safety or value for children. It cannot be adequately replaced by any artificial substitute. Passing from the clean healthy breast to the mouth of the child, the milk is also secure from contamination. Human milk varies in amounts secreted and in composition. This variation may be marked but is usually very slight. It is generally found that in most cases a small output or poor quality of milk at one time is compensated by a greater yield or a richer milk later. Human milk is richer in lactose (sugar of milk) but poorer in fat, proteid, total inorganic salts and especially in phosphates and chlorides than the milk of the goat and cow. The fat of human milk contains a much smaller quantity of volatile acids than that of cow's milk, and the casein does not exist in combination with calcium phosphate and is thrown down by acids in a very finely divided state. The enzyme oxydase does not appear to be a normal constituent of human milk. There are striking biological differences between human milk and other milks and the former also contains the greater quantity of important non-nitrogenous substances of an unknown character. If cow's or goat's milk is to be fed to infants, it is usually modified by dilution so as to lower the fat content. Frequently lime water or milk of magnesia is added to this modified formula so as to prevent the curd from lumping, the latter coagulating more readily and being denser than that formed from human milk. The milk of the Holstein cow is more like human milk than is that of the Jersey cow and is most frequently better tolerated by infants than the latter. Asses' and mares' milks resemble human milk in the nature and amount of proteins which they contain, and for this reason are recommended at times for infant feeding when artificial milk is to be employed.

Chemical Analysis of Human Milk

Many hundreds of samples of human milk were analyzed by the writer during the past fifteen years and herein are tabulated the findings:

	Fat	*Protein*	*Lactose*	*Total Solids*
Minimum	1.2%	0.5%	3.6%	5.4%
Maximum	6.4%	4.1%	8.2%	15.6%
Average Findings	3.8%	1.6%	6.1%	11.8%

The specific gravities varied from 1.027 to 1.033; and in several instances where ash determinations were made the content of the latter varied from 0.1 per cent. to 0.5 per cent., and the ash content in most samples of human milk averaged 0.3 per cent.

Sources of Bacteria in Human Milk

There is no doubt that human milk is rarely, if ever, bacteria free. Specimens that were collected under the most favorable conditions showed the presence of bacteria. This is not due to the fact that the healthy milk gland does not secrete a sterile product, but mainly for the reason that bacteria probably find their way through the nipples and other sources. Furthermore, there is little cause for arguing this question, for, after all, whether milk secreted by the milk glands is or is not germ free, it is a known fact that the milk at the time it is taken by the child, contains bacteria.

The bacteria of the healthy mammary glands form but a small proportion of the total bacterial content in milk consumed during nursing. The skin of the mother, directly or indirectly, through clothing, handling, etc., contributes the abundant quantity of bacteria found in human milk and fed to the child. How many pediatrists and physicians advise the cleansing, washing, or merely wiping with a wet cloth, of the nipple and surrounding area, before nursing? And how many mothers actually take such precaution? The mother may heed this advice for the first few weeks but then she becomes careless or forgetful, and one finds many mothers handling their breasts preparatory to nursing the child, forgetting to wash their hands or the nipples or both.

In six different samples of human milk, collected under conditions almost identical with actual conditions at the time an infant is about to begin nursing, after a careful bacteriological examination I found only two of the samples of such a bacterial count as to

regard the milk fit for consumption. The other four had a bacterial count ranging between 1,110,000 to 4,260,000 to the c. c. In the case of cow's milk, we hear of the cleansing of the skin and udder of the cows, the hands of the milker, the vessels used for collection, and other implements. Why not observe precautions of cleanliness in the case of human milk?

It cannot be pointed out too frequently that the excessive bacterial contamination in human milk is not only avoidable, but unnecessary. It can be prevented to a large degree by closely guarding the simple rules of cleanliness. This involves no increase in expense. It usually means less suffering, little or no worry, and, if anything, a decrease in expense in the long run. The time may come that the science of bacteriology will develop to an even greater exactness than it is today, and the direct relationship between many of the diseases of children may be traced to mother's milk, contaminated carelessly from the skin.

In addition to the previously outlined sources of contamination, there may be another: that is, from a diseased mammary gland. The latter, when diseased to such an extent that a physical diagnosis reveals the fact, quickly places the attending physician on his guard. But it is those diseased conditions, wherein the mother apparently feels no discomfort, and where, nevertheless, an inflammation (or mastitis) exists, which produce a serious source of danger.

Animal Milks

Human breast milk is the natural food of the infant. Artificial feeding must however be employed for those infants where the mother is unable to nurse her child, due to illness or due to an inadequate or unsuitable milk supply. Wet nurses are usually not available. Even breast milk procured from healthy mothers and pasteurized before distribution, if available, is obtainable in but limited amounts. In such cases a modified animal milk is the substitute for the breast milk. When the milk of other animals is employed to take the place of human milk, it is modified or prepared as to make the proportions of its different constituents approximate the composition of human milk, the natural food of the child. But it must also be remembered that not all milks coming from different animals are satisfactory for the young of another species. For the older baby, school children, adolescent children, young and old adults, animal milk is the only type milk which is available. In this country the animal milk generally employed and the almost universal substi-

tute for mother's milk is cow's milk, while in certain quarters where the latter is not obtainable, goat's milk and occasionally sheep's milk are employed.

Cow's Milk

In our country, when the word "milk" is used without any qualifications, it is generally understood that we refer to cow's milk. The opinion is rather overwhelmingly in favor of fresh cow's milk as a substitute for human milk. Mention should be made at this time that other animals are supplying milk to nourish the human family but more details will be given later. No one however can question the statement that the cow more so than any other animal has furnished the great bulk of the world's milk supply used by humans, and the cow is rightly entitled to be called (as she has) the "foster mother of the human race."

There are in existence wild cows and in much greater numbers domesticated cows. Some of the latter are more valuable for their beef, while many of them are notable for their milk. Some breeds are the "dual purpose" cows, serving both purposes for milking and beef. The white-faced Hereford, an English breed, and the Aberdeen-Angus, a native of Scotland, are examples of breeds valuable mainly for their beef. The Shorthorn, Red Poll and the Polled Durham are valuable both for milking and beef, so called "dual purpose" breeds. The Shorthorns, Holsteins, Jerseys, Guernseys, Ayrshire and the Brown Swiss are breeds pre-eminent as milk cattle.

The following table will give an approximate percentage of the fat and solid contents of the breeds mentioned above and notable as milk cattle.

	Fat	*Total Solids*
Holstein	3.4%	11.9%
Ayrshire	3.6	12.7
Brown Swiss	3.6	12.6
Shorthorn	4.0	13.2
Guernsey	5.1	14.7
Jersey	5.2	14.9

There are at present in the United States over twenty-two and one-half millions of milk cows, approximately one cow for each five people, these cows supplying milk and milk products used in this country and for export trade. It is interesting to note that Illinois, Iowa, Minnesota, New York, Pennsylvania, Texas and Wisconsin

possess within their borders almost one-half of this total of dairy cows. Various factors control the location of dairy cows and the dairy industry, as: climatic conditions favoring green pastures, favorable weather conditions, where grains are obtainable at a cheap cost, where hay is grown extensively, proximity to large markets and easy facilities of transportation to the latter, where dairy products command a high price, etc.

Variations in the Composition of Cow's Milk

Milk from individual cows varies markedly in its composition. Natural conditions which influence the variations in the yield and quality of milk are: the breed and individuality of the cow; its age and health; the kind, quality and quantity of food given to the cow; indoor or outdoor feeding; amount of water consumed; climatic and weather conditions; periods of lactation or milking; number of daily milkings and intervals between them; fatness at time of giving birth to young; experience and efficiency of the milker; milking by hand or machinery; and stage of milking (for instance the last drawn milk from a cow, called the "strippings," is richer in fat than other portions).

Individual cows may reveal a wide variation in the constituents of the milk which they yield; and it is not infrequent that one will find where one or two cows are supplying the milk for the household, as on a farm, the product made available is below the legal standard for butter-fat and solids-not-fat. Commercial milk, however, as it reaches the consumer, is a sample obtained from the mixed milk of a herd of cows. The greater the number of cows, that is, the larger the herd whose mixed milk is represented in the sample, the more constant will be the constituents of milk.

Market Milk

Animal milk and mainly that from cows is used in its fluid state as an important and valuable food in the diet of humans. Milk thus consumed is referred to as "market milk" to differentiate this from milk employed for manufacturing the so-called milk products, as cheese, butter, buttermilk, ice cream, milk powders, etc. It is to be remembered that milk presents a very difficult market problem not only because of its high perishability, but also due to the fact that there is present a continuous supply of this liquid food. It is not a seasonal product or one obtainable only at certain periods. The production may exceed the demand; and it is then that this surplus of fluid milk is manufactured into other products which have a ready sale and which can be kept more readily

for long periods of time. However more milk is consumed as milk than is employed for the production of milk products. On the other hand, we find that owing to its nature fresh fluid milk is one of the few products practically free from foreign competition. This is not the case of concentrated and dried milks and milk products. During 1929 the milk consumption in the United States was 58.7 gallons per capita per year or, on an average, nine pints of milk were consumed by each individual in the United States every week. This is in contrast to 17.6 pounds of butter and 4.6 pounds of cheese per capital per year or 5.4 ounces of butter and 1.4 ounces of cheese per individual per week. Add to this the average per capita consumption during 1929 of condensed milk (2.75 pounds per capita per year), evaporated milk (13.83 pounds per capita per year), and ice cream (twenty-four pints per capita per year), the total will still be a fraction of the per capita consumption of milk as a liquid. A quantity of milk approximately equal to that marketed is estimated to be consumed on farms for feeding humans and animals, etc., and this never enters the market.

For comparison, the consumption of fluid milk per capita per day in the following countries is:

England and Wales—approximately one-half pint; France—one-third pint; Denmark and Sweden—one and one-half pints; and Switzerland, one and four-fifths pints.

Milk Sanitation

The consumer regards the bottle of milk he buys as part of the day's routine. Like many similar transactions its purchase and consumption is taken as a matter of course. Little does he realize the trouble, care and attention which was given in its production and perhaps he cares still less. It is when a spoiled product is about to be consumed by him that he may give some consideration to the thought of its production. Great care is required in the production and distribution of market milk so as to be assured that a safe product is supplied to the consumer.

In days gone by milk was consumed by those individuals who owned a cow or lived near a farm where milking cows were to be found. All the milk was consumed at the source or close to the source of its production. You may have heard of the milk dealer leading his cow to the prospective purchaser, and the milking performed to yield in each case an amount equivalent to the price paid or the quantity desired. In most all cases, however, milk was avail-

able, as the communities were small. The latter consisted of a fair percentage of agricultural individuals, and the problems we encounter today in our complex city living conditions were not known. As the agricultural population became separated farther away from cities and from the dairy markets and the large number of consumers of its products, some system had to be evolved to obtain a plentiful supply of fresh milk in the same condition as when it left the cow's udder. It did not take long to find out that milk, the most bulky and most perishable of foodstuffs, could be marketed and presented as a safe and satisfactory product only after a very elaborate system of sanitary control was instituted, and all regulations promulgated by the latter were rigidly enforced. The production of market milk carries with it many responsibilities, and everyone concerned in the production, handling and marketing of this foodstuff, including the consumer, must share in these responsibilities.

Bacteria in Market Milk

Milk is an excellent culture medium pre-eminently fitted for the growth and development of all kinds of bacteria, those that do not produce disease as well as those varieties which produce disease. All milk even if collected under very exceptional conditions contains bacteria. Even if the cow is healthy, some bacteria are always found in the milk ducts and teats, on account of the anatomical location of the udder and the possibility of contamination by hand milking. Milk therefore as received in the pail after the process of milking is contaminated with bacteria. There are numerous possibilities of additional contamination or bacterial invasion from outside sources, as from dirty utensils and containers, dust and dirt in the barn and air, and from other sources to be mentioned later. Even if only a few bacteria were present originally, millions would develop over night if the milk was kept at a warm temperature, as under favorable conditions bacteria begin to multiply within twenty minutes after their existence or birth.

Kind of Bacteria in Milk

Most of the bacteria found in milk are harmless. They include almost all known varieties. The most common types are the so-called milk bacteria, so named because they are frequently found in this liquid food, and which cause the latter to sour due to the decomposition of the milk sugar and the production of lactic acid. Other bacteria are capable of producing a butyric acid fermentation, causing the odor charac-

teristic of rancid butter. Occasionally changes by some types of bacteria may be observed in which there is produced the so-called "slimy milk," yellow and green milk, and "bitter milk." It is evident that such milk which may be thus contaminated resulting in a sour, slimy or tainted product will mean a loss of money to the producer, complaints by and loss of confidence of the consumer and other annoyance.

Milk and Infectious Disease.

In addition to the bacteria previously mentioned, it is known that disease-producing bacteria may be present in milk. Unfortunately their presence is not indicated by any gross changes in the milk, as production of an abnormal color and odor, coagulation, marked acid production, etc. Individual cases and epidemics of many diseases have been definitely traced to contaminated milk supplies. Two sources of infection are recognized: (1) a small number of disease conditions and few epidemics have probably come from the milk of diseased cows; and (2) the more common source of contamination is the introduction into the milk of infectious material of human origin.

The first milk epidemic of which there is any record was the typhoid epidemic in Penrith, England, reported by Dr. M. W. Taylor in 1857. Hundreds of outbreaks of typhoid, caused by infected milk, have been recorded since then and until more recently when pasteurization of milk was introduced. Such epidemics are generally traceable to diseased or convalescent persons or carriers employed in the dairies, to well or other waters contaminated with typhoid bacilli and this water being employed in washing milk utensils, to flies present under insanitary conditions, or to the use of bottles or containers coming from homes where cases of typhoid fever had existed, and which were not sterilized properly before being refilled.

Other diseases traced to the use of infected milk are diphtheria, scarlet fever, septic or streptococcus sore throat, dysentery, diarrheal or gastro-intestinal disorders, and foot and mouth disease. In certain countries where goat's milk is widely used, Malta fever may be disseminated by infected milk. There also seems to be some evidence that Undulant fever may be milk-borne. It is possible for milk to become infected with tubercle bacilli from tuberculous persons who are employed in the milking or handling of milk; and the transmission of a certain type of the tubercle bacillus due to the ingestion of infected milk of tuberculous cows has been proven.

Minimizing Danger of Milk Infection So as to secure safety for the public at large against the many diseases which can be spread by milk, elaborate methods have been introduced: careful inspections of farms, plants and all dairy establishments; constant laboratory control; prompt efficient cooling of all milk, and refrigeration during transportation; periodic health examinations of all milk handlers; the tuberculin testing of milk cows; pasteurization, etc.

Keeping down the total bacterial content is also in the interests of the dairy industry as it reduces spoilage. Everyone in the milk industry recognizes the fact that a clean and safe milk is an important factor in the continual and ever-increased use of this liquid food. Human health is dependent upon a pure milk supply.

Legal Control The first laws which were framed dealt with chemical adulteration and the addition of preservatives. This assures a product to the consumer wherein he receives full value in food material for the money expended. It protects the purchasers of milk against fraud. The farmer today sells his milk to the creamery on the basis of its butter fat content, and large buyers of milk and certain milk products purchase the latter on the basis of such fat content. Watered and skimmed samples of market milk and milk low in fat are only to be found in negligible amounts today; and then it is generally found that a small dealer who has not utilized laboratory facilities has erred. It is, however, unfortunate that there is a variation in chemical standards for market milk as regulated by different states. There are also few states that have not established standards. In most of them the chemical standards for milk require from 3 per cent. to 3.25 per cent. butter fat and from 11.5 to 12 per cent. of total solids. On the other hand we find that in Rhode Island the food and dairy departments under legislative authority require milk to possess but a 2.5 per cent. fat content; and the District of Columbia by the act of Congress requires 3.5 per cent. butter fat in market milk. Idaho requires 11.2 per cent. and the District of Columbia 12.5 per cent. of total solids in this product. There is really no good reason for such variations.

Milk Ordinances Though with but very few exceptions, state laws have been enacted for the proper chemical control of milk, ordinances to improve and safeguard the milk supply from the health standpoint have been left to the guidance of the health officials or special commissions in the various communities of these

states. Such ordinances give the health authorities a reasonable, practical and operative means of supervising, controlling and protecting the milk supply. They promulgate regulations concerning the sanitary conditions to be observed in the production of milk and prescribe limits for bacterial contents. This is for the protection of the health of the consumer. It is however unfortunate that there does not exist a uniform and effective milk control program throughout all communities in a state, and better still, throughout our country. There are hundreds of small municipalities too small to function effectively, and entirely too many local milk ordinances and regulating private milk commissions which tend to confuse matters. Programs of unification and stabilization of milk-control methods, including the chemistry and bacteriology of this product and the sanitation to be observed in its production, marketing and grading, should be statewide. Proper legislation along these lines should be enacted or there should be a closer co-operation between the various health bureaus and milk commissions in the state. There is no reason why the health department in Philadelphia or any other large city should adopt its own regulations, and communities in the suburbs of these cities are not bound by bacteriological or sanitary standards, or in some instances their program may be more rigid.

Dairy Farm Sanitation

The sanitary conditions on the farm and the sanitary methods employed in obtaining and delivering the milk collected here is the first important significant factor in the production of a pure and safe milk.

Cattle

Every cow from which market milk is secured should be healthy and well nourished and free of any physical disability due to disease. The value of the tuberculin test for the detection of tuberculosis and the elimination of all cattle showing a positive reaction cannot be overestimated. The failure of this test in diseased animals is rare and an accurate diagnosis is possible in most diseased cattle. Animals should be tuberculin tested at least once a year, and given thorough physical examinations by a competent veterinarian. Clean wholesome feed and a plentiful supply of pure water should be supplied at all times.

Under conditions prevailing on farms, cows accumulate dirt, filth, mud, manure, etc. The udders, teats, bellies and flanks of the cows become heavily laden with bacteria from this accumulated material depositing on their bodies. It is more than probable that such

organisms will find their way into the milk pail during milking, unless the cows are thoroughly cleaned and groomed to keep them free of accumulated foreign matter, clipping long hairs on the udder, belly and flanks, and finally washing well and wiping the udder and teats with clean water before each milking.

Dairy Barns

The barns and stables in which cows are kept should have a well-drained location, free from contaminating surroundings, and should have provisions for an abundance of light and proper ventilation. The walls and ceilings should be smooth and tight, whitewashed or painted; and the floor should not be of earth, but tight and sound, made of concrete or other impervious cleanable material and incapable of absorbing odors. If the ground is of soil, water holes and a muddy barnyard should be avoided. Other animals or pets should not be permitted in the parts of the barn where milking is conducted. A sufficient quantity of clean bedding preferably clean shavings, should be supplied. Manure should be removed at frequent intervals. Wherever possible, screening of windows and other openings should be practiced. At least 400 cubic feet of air space should be allotted per section for each dairy cow. Cows should not be allowed to pasture on low, swampy land.

Utensils

All utensils must be of smooth, non-absorbent material and so constructed that there will be no difficulty in cleaning all parts of such utensils. The latter should not only be cleaned immediately after use, but also sterilized either with water, or chlorine solutions, and then stored and handled in a manner as to prevent contamination before again being used.

Milking

Milking should be done in an environment free from dust and odors, and milkers and milk handlers should wear clean outer garments. The cow's udders should be cleansed as mentioned previously. The milker who, must be healthy, free of any communicable disease and not a carrier, should disinfect his hands, dry them with a clean towel, and milk only with clean, dry hands. Wet hand milking is to be avoided. The first streams of milk from each teat, generally known as the "Fore Milk," should be collected in a separate receptacle and discarded. This fore milk usually contains large numbers of bacteria. Bloody or stringy milk should be rejected and the cow yielding this should be isolated until the milk is normal in all respects. The operation of milking requires ap-

proximately eight minutes, and is usually conducted twice daily, yielding on the average from eight to twelve pints at each milking. Milking machines imitating the motion of the hands are used by some dairy farmers, wherein four cups are placed over the four teats of the udder; and if the apparatus was properly cleansed and sterilized, clean milk will be obtained in the receiving vessel. The latter, which is to receive the milk directly from the cow, should be a clean and sterilized small-mouth pail with a hood or cover possessing an aperture not over five inches in diameter. Care should be given in selecting the hooded or covered milking pail as herein described, as it is an important factor in keeping contamination from the outside down to a minimum.

Milk House or Milk Room

A separate milk house or milk room which is to be kept clean at all times should be provided and fitted for the use to which it is to be put. This building or room should be preferably separated from the barn, well lighted and ventilated, screened, possessing whitewashed or painted walls, concrete floor and painted ceiling, and so situated as to be free from dust, odors or anything which will contaminate the air therein. It should be near the barnyard, and the milk should be brought to this room as soon as it is collected. Here milk is strained, cooled, bottled or canned and stored in a cooler or in cold water or by other means of refrigeration, at a temperature below 45 degrees Fahrenheit. If washing and sterilizing of all utensils is done in this house, this should be carried out in a different room of the milk house.

Transportation of Milk

At regular periods the milk usually in large cans is transported by trucks to the country milk plant (supplied by milk dealers). The milk is received, cooled, canned and the required amount is shipped to the city plant to be pasteurized, bottled and sold. In some instances the country milk plant is equipped to pasteurize and bottle milk, although pasteurization at the city milk plant is cheaper and to be preferred. In all instances only the milk which can actually be sold is shipped from here to the city and the remainder is utilized depending upon the equipment present and which may be for separating the cream and manufacturing cheese from the skim milk, or the production of milk powder or other milk products.

In other cases the milk is transported to the city plant by direct shipment in large cans by truck or railway or through country sta-

tions or from here after it is collected and assembled. The modern method on a large scale is to ship the milk in huge glass-lined tanks or tanks lined with nickel or made of chrome steel, mounted on motor trailers or in special freight cars. These tanks and cars are specially constructed for milk transportation, have a capacity of 8000 or more gallons of milk, and they are constructed with a refrigerating system and insulated walls.

The City Milk Plant

Economy of operation as well as sanitation are considered in the arrangement of a milk plant in the city as: the kind of material used in its construction, proper ventilation and light, and inside walls, ceilings and floors which are durable, waterproof and made of smooth material which can be easily cleaned. Provision is made for the rapid receiving of the milk, which after being weighed, graded and samples collected for laboratory testing, is delivered by conveyors to the receiving room. Where the milk is delivered in cans, the latter as soon as they are emptied are cleaned well with chemical solutions and hot water, then several rinsings of hot water and live steam and the same empty cans are returned after but very little delay. Tank cars are also cleaned thoroughly and sterilized after each load.

The milk is then passed (or pumped) to a storage tank (provided with a cooling system), and when ready to be pasteurized, it is first passed through a clarifier to remove dirt or other foreign matter and sediment.

Pasteurization

Between 1860-1870 the famous French chemist, Louis Pasteur, revealed that if wine and beer were heated at a temperature of approximately 140 degrees Fahrenheit or higher for a short period of time, the loss from spoilage was prevented. The process became known as "pasteurization" and was used throughout Europe for beers and wines.

In 1886 Soxhlet in Munich recommended the boiling or pasteurization of all market milk. Dr. Jacobi, the eminent American pediatrist, recommended the boiling of milk as early as 1873; and in 1895 he began advocating pasteurization. Flugge created a dubious frame of mind among scientsits concerning the pasteurization and heating of milk, when in 1894 he reported that milk was injured by the heating process and that infants fed on such a product were adversely affected. It required many years of constructive work by a host of careful investigators to restore the pasteurization of milk to

the secure position it justifiably occupies today. The work by Park and Holt, by Rosenau and later by North aided considerably in producing the impulse needed to adopt pasteurization universally. Park and Holt conducted feeding experiments on tenement house babies, in which groups were fed on pasteurized milk and others on raw milk purchased from the dealer at the corner store. Those fed on the latter product showed a high mortality as compared with the group fed on pasteurized milk. Later, Rosenau revealed that the thermal death point (the lowest temperature which so affects bacteria that they lose their disease-producing properties and are unable to grow and develop) of the bacteria found in milk, and which may be disease-producing or might decompose the milk, are destroyed when heated at a temperature of 145 degrees Fahrenheit for twenty minutes. North in his experiments showed that the taste of milk and the rising of the cream were not affected by this temperature even if exposed for thirty minutes.

For many years heating processes, the sterilization or pasteurization of milk, were conducted in the home by the consumers themselves. Such procedure, if used, was only attempted by comparatively few consumers and frequently at irregular periods, but was wholly inadequate as a measure to secure effective and worthwhile results for the majority of the people. It was to be expected therefore that far-sighted public health officials would seek more satisfactory methods of handling this situation, and with that in mind, they sought to establish pasteurization of the entire milk supply at the milk plant proper.

The heating of milk was practiced on a commercial scale by some dealers without the knowledge of health officials or the consumers, and even before the process of pasteurization was recognized by health officials in general. They usually employed the various types of "flash heaters," by a method which subjected the milk to a quick momentary heating employing temperatures from 150 degrees Fahrenheit to 165 degrees Fahrenheit. The latter high temperatures frequently produced a cooked taste to the milk, affected the cream line, and this coupled with the fact that the machinery employed was uncertain in operation, also resulted in a delay of establishing pasteurization as a method to be used on a large scale by the milk industry.

The introduction of the "holding method" of pasteurization, producing a reliable, safe, palatable and satisfactory end product, soon established this procedure as one deserving the confidence of the milk

dealer, the public, and the health official. The perfection of this process on a commercial basis has supplanted the use of home pasteurizers and other commercial techniques of pasteurization. It is the method recognized by health officials as the most satisfactory one for pasteurization. Health authorities in large communities require milk to be pasteurized (unless sold as raw milk under certain regulations), and in many instances they stipulate the type of apparatus to be employed. It is of interest to note that in most all instances ordinances or regulations requiring pasteurization when questioned have been sustained by court decision.

Heating Milk

The question of the effect of heat on the nutritive value of milk is of great practical importance today, inasmuch as heated (or pasteurized) milk and heated milk preparations (dried and condensed milks) are used in greater amounts than is raw milk. There seems to be a firmly established belief in some quarters that heated and in particular boiled milk is unsatisfactory, not as nutritious and that it is constipating. Clinical and experimental evidence gathered thus far show an advantage existing on the side of the heated product, and there appears to be no basis for the claim that raw milk is more digestible and less constipating than heated milk.

The "Holding Process" or "Pasteurization as Practiced Today"

This system of pasteurization, as practiced today, consists of heating the milk to 145 degrees Fahrenheit and holding it at that temperature for thirty minutes. Pasteurizing machinery consists of heaters, holders and coolers. Approved apparatus adapted to the particular plant for which it is intended must only be used, for not all pasteurizing equipment possesses the proper fittings, so that the milk in every part of this apparatus will be under the influence of a temperature of 145 degrees Fahrenheit for the required length of time. Pasteurization improperly conducted misleads the consumer and gives a false sense of security. Milk sold as pasteurized milk should be pasteurized by recognized scientific methods.

In operating the pasteurizing plant, the milk is heated and held at the proper temperature with an accurate control (preferably automatic) of the temperature and a control of the time. It is then chilled and run into tanks in a well-insulated storage room, and kept at a temperature of 50 degrees Fahrenheit or below. The pasteurizing outfits are supplied with recording and indicating thermometers. The apparatus, pasteurizer, etc., which have come in contact with the milk

are thoroughly washed, cleaned and sterilized by steam, immediately after being used.

Pasteurization and Cream Line

Many individuals judge the richness of their milk by the visible cream line or layer which forms in all milk, after the latter remains in the bottle for a short period of time. One of the objections raised by the milk dealer is that the cream line in the milk is affected by pasteurization. The fat or cream is not changed but a reduction of the creaming ability (that is, for the cream to separate and form a visible layer) is caused by high temperatures. This is attributed to a change in the state of suspended casein, resulting in the milk acquiring a somewhat slimy consistency which retards the subsequent separation of cream. It is therefore to be found that some pasteurizing plants employ a temperature not exceeding 143 degrees Fahrenheit. This is objectionable. Efficient pasteurization, employing a temperature of 145 degrees Fahrenheit, if it causes a decrease at all in the cream layer, produces a reduction in this creaming ability which is not noticeable, or one which is not serious, especially if satisfactory apparatus and methods are used and the milk is properly handled after pasteurization.

It is of course not desirable to use high temperatures for pasteurization when lower ones (and 145 degrees Fahrenheit is effective) are just as satisfactory and do not cause creaming difficulties. It is an erroneous judgment held by the layman that the cream line is an indication of the richness of the milk. A more serious opposition to the complete disappearance of the cream line is the fact that some consumers are financially unable to buy cream separately. They have adopted the custom of using the cream or top milk for coffee, cereal or dessert. It would be a most difficult task to change this custom suddenly or to educate people in general to a disregard of the cream line and not to lay so much stress upon its significance.

Value of Pasteurization

Even though machinery is now employed in milk plants in handling the milk when it arrives and until it is ready to leave in bottles or other containers, and all regulations are enforced by close supervision and inspection at the farms, during transportation, and at the milk plant, it is practically impossible to prevent all outside contamination. Accidents beyond human observation and human control may lead to a serious milk contamination. Pasteurization supplies an additional factor of safety, and for this reason it is to be highly recommended. If the process

of pasteurization is conducted properly, all disease-producing bacteria in milk are destroyed. The life of the milk is also prolonged, for by this process there is a reduction in the numbers of bacteria commonly found in milk, and which are capable of decomposing this product.

Approximately 99 per cent. or even a greater percentage of the total bacterial content is destroyed by proper pasteurization. It must be distinctly understood that there is rarely 100 per cent. destruction. The remaining organisms are usually non-disease producing, heat resistant and capable of decomposing the milk if they are allowed to grow and multiply, resulting in the production of large numbers of bacteria from the comparatively few present originally. It is therefore important to cool the milk immediately after pasteurization and to keep this product at a temperature below 50 degrees Fahrenheit (preferably between 35 degrees Fahrenheit and 45 degrees Fahrenheit). Low temperatures, though they do not kill bacteria (only after very long exposures), prevent them from developing, multiplying and exerting their effects.

At one time there existed some opposition to pasteurized milk, and even to those methods of pasteurization properly performed. The statement made previously can well be repeated here again. Pasteurization, improperly conducted, misleads the consumer and gives a false sense of security. Milk sold as pasteurized milk should be pasteurized only by recognized scientific methods. This is one of the reasons why inspection of milk plants is necessary. The mere presence of satisfactory equipment gives no assurance that the proper methods will be employed. It is the duty of the milk inspectors to watch all pasteurizing plants.

Other than a diminution in the vitamin C content and a slight increase in the time required for coagulating the casein by rennin, pasteurization at 145 degrees Fahrenheit does not alter and cause changes in milk. These changes are not objectionable and the fact that most diets, even that of the infant on cow's milk, is supplied with other foods containing vitamin C, there can be no objection to a slight decrease of the latter in pasteurized milk, for the benefit to be derived in the added safety of the latter. There should be no fear that pasteurization in some way injures the physical quality, the wholesomeness or the digestibility of milk. All milk (except raw or certified) should be pasteurized, if we are interested in reducing infant mortality and observing progress in public health.

Bottles, Bottling and Capping

After pasteurization is completed and the milk has been cooled, it should be placed immediately into clean, sterilized containers. The latter should receive special attention. Even though the milk which is about to be placed in the marketable containers has been closely safeguarded and a product very low in bacterial content is the result, there is great danger of contaminating the milk due to the fact that dirty and unsterilized cans, bottles or other receptacles are employed. Containers for the receiving of market milk must be clean and sterile.

Health authorities insist upon market milk being supplied in sterilized individual bottles. Dipped milk, that obtained from a large open can and dispensed by a dipper to each customer, may be variable in its fat content and not be of a uniform quality, because most frequently the container is not agitated or the contents stirred well. Many opportunities of contaminating the milk in the can is afforded by this procedure, and the milk will be found to be invariably high in bacterial content. Dirt and dust get into the container each time it is opened, the dipper and container are most frequently dirty, and such milk is really unsafe for human consumption. Strong glass bottles are employed at present as containers, and these are examined (especially the cap seat and bottom) for defects; and if perfect, they are washed, sterilized and cooled. Washing and sterilization are performed by machinery. Here various chemical baths are employed, starting in with a lukewarm solution of lye, gradually increasing the heat and strength of lye, and in some instances other chemicals are employed, especially tri-sodium phosphate, when needed to clean the sediment formed in milk containers. After several rinsings with hot water and additional sterilization either with a weak chlorine or hypochlorite solution, or by steaming, the bottles which are by now practically dry are inverted until ready for use. In most instances they are cooled and conveyed immediately to the automatic machine bottle filler, where again bottles are inspected for defects and also for cleanliness before being filled. Only cooled bottles should be used for filling, so as to avoid a rise in the temperature of the milk placed in them and a corresponding increase in the bacterial growth, due to an increase in the multiplication of the organisms present. There is also a saving in refrigeration if only cooled bottles are employed.

In modern plants, bottling (filling) and capping are done by machine. Where filling and capping or even capping alone is to be done by hand, great care should be observed to prevent contamination

of the milk and the cap seat or mouth. Various automatic power fillers and cappers are in use, the type depending upon size of the plant facilities for filling large numbers of bottles, cost, etc. The protection of the mouth of the bottle by an outside covering, unless the cap employed is a combination of cap and mouth cover, is to be highly recommended. This keeps dust, dirt, flies, etc., away from the cap, so that when the milk is to be poured, there is no need to worry that filth and bacteria on the top of the bottle will be washed along. Ordinarily, the average individual does not wash the top of the bottle (which is only capped) to remove dust and dirt. Frequently facilities for such washing may not be available. The use of the outside covering therefore means an additional safeguard for the public health. The caps and outside coverings are generally purchased in closed containers, and are sterile or almost so.

Pasteurized milk and cream are also sold in bulk, but this is usually supplied to bakeries, confectioners, hotels, restaurants and the milk is generally heated and employed in cooking.

The filled containers, unless ready for immediate delivery, should be sent at once to the cold storage room until ready to be loaded for delivery. When any considerable length of time is required in the delivery of a load, the containers should be well iced.

Cleaning of Machinery, etc., and Refrigeration

It is most important to cleanse thoroughly and sterilize (with steam or chlorine solutions followed by steam) all machinery, equipment and apparatus as soon as the milk leaves them. Pipes should be disconnected wherever possible and solutions of chemicals are to be employed when necessary to get rid of the milk residue. Care should also be taken to see that leaky valves in any of the machines, tanks or equipment are not present, for other than causing a loss of milk, they are insanitary.

Wherever possible, mechanical refrigeration is to be preferred to ice. Not only are better results obtained, but in an establishment as a milk plant, we find that a cleaner and more sanitary environment can be made possible. The temperature can be more accurately controlled, and the cost in the long run is usually cheaper with artificial or mechanical refrigeration than would be if ice was used.

Frozen Milk

Mention was made that milk, wherever possible during its various stages of production and at all times during storage and transportation, should be kept cool, below 50 de-

grees Fahrenheit and preferably between 35 degrees Fahrenheit and 45 degrees Fahrenheit. At no time should milk be frozen in order to preserve it. The freezing of milk yields a product which does not possess the desirable aroma and flavor of fresh milk and these may be objectionable and even offensive; it affects the cream line or cream column; and it intensifies any undesirable flavor which may not be perceptible in the original fresh, cooled sample.

Inspections

Modern scientific methods have proven that the many and varied operations as mentioned are necessary, if it is desired that a wholesome and safe milk is to be marketed. To be assured that the dairy laws and milk ordinances were being observed, milk and dairy inspection was instituted. Milk and dairy supplies in all large communities are subjected to a most careful and thorough inspection starting from the producer until the product reaches the consumer.

Sanitary inspection begins at the source of the milk supply, on the dairy farm. Any plan which neglects sanitary precautions during production and relies solely upon pasteurization is faulty and not sound. The inspection is equally essential for milk later to be pasteurized as for milk to be marketed as raw or certified milk. Precautions during production as well as during pasteurization are both desirable safety factors which are needed to provide the maximum in safe milk. Neither one is sufficient by itself. Emphasis is given here to the hygienic conditions of the dairy farm and the health of the cows, and include data concerning the location and construction of the stable and surrounding buildings, provisions for light and ventilation, exclusion of flies and other insects and animals from the herd, construction of stanchions, bedding, cleanliness and condition of the air in the stable, methods of disposal of manure, feed employed, and quantity and purity of water supplied to cows for drinking. The health of the cows is considered, whether they were tuberculin tested, their cleanliness, and especially the cleanliness of the udder and flanks and the clipping of long hairs, the milk which they produced, how often milkings are practiced, and how these milkings are made. The milker is examined to be sure that he is healthy and not a carrier of disease germs; he must disinfect his hands before each milking and perform the latter when his hands are dry; wear clean outer garments; and he is watched to be sure that he conducts milking under as sanitary conditions as is possible, using clean and sterile hooded

milk pails for receiving the milk after the udder is cleansed. All employees are to be healthy and observe the routine regulations of personal cleanliness. The cleanliness and sterility of all utensils and containers used, and the methods employed to sterilize them are noted. The condition of the dairy house or room, the sterility of the receiving vessels, kind of cooling system used, the purity of the water supply and the methods employed in transportation are all carefully guarded.

At the country creameries or collecting points, inspection is carried out along similar lines and other control steps are applied. It is here where samples are collected, and the laboratory tests as will be mentioned, are conducted to determine the exact chemical and bacteriological findings.

The milk is then transported to the pasteurizing plant either from the creamery or directly from the farm. Here the inspections are just as rigid. Mention should be made that particular attention is given to the care which milk receives during transportation. Notations are made to be sure that proper provisions for icing or refrigeration are made, regardless as to the method of transportation.

The city milk plants or pasteurizing depots also require and receive careful inspection. The equipment is checked, the arrangement and cleanliness are noted, and particular care is given to the methods of handling the milk, sterilizing the containers and equipment holding milk, health of employees coming in close contact with this liquid food, the types of automatic devices employed, and the accuracy and control of the method of pasteurization. Methods of filling bottles and containers, storing and delivering of the finished product, and the control of diseases in milk plants and on the farm are carefully guarded. Here again laboratory tests are conducted on the products to be marketed and these are ready to be graded. Inspections are even conducted in all stores selling market milk so as to observe their facilities for keeping this product, the quality and freshness of milk sold, whether dipped milk is dispensed, etc.

Pasteurization vs. Inspection

It cannot be emphasized too strongly that these inspections all along the line from the producer to the consumer and constant laboratory control are absolutely essential, even though pasteurization is conducted. Pasteurization is not intended nor can it be expected to take the place of the sanitary control and the proper supervision of milk production. It constitutes an additional safeguard to milk, and is not to be used

as an excuse for careless and insanitary methods in the production of market milk.

Milk Bottle Losses

The bottle supplying milk belongs legally to the dairyman, and is only loaned to the consumer. Milk bottles are usually made of a high-grade glass of heavy construction and of good workmanship, and accordingly the cost of these containers is necessarily high. The price will depend upon the quantities purchased, but the average milk bottle in quantity purchases costs between four and five cents. Some breakage is to be expected, and bottles broken within the plant may be salvaged. But bottles broken in the home or during delivery, those thrown in with the rubbish, etc., and those stolen or through carelessness used for receptacles of almost everything in and around the home or shop, and later destroyed, mean a total loss to the milk dealer. More important than that, it means an increase in the production cost of the milk. Millions of dollars are lost every month by the dairies throughout the country, due to carelessness or forgetfulness resulting in the loss of milk bottles. Thoughtlessness is more frequently to blame for this condition. At times the milkman delivering the milk who also collects the bottles may be at fault. I have seen such empty bottles remain on steps for days before they were collected, and I have even observed boxes of these containers left at a convenient location for collection remain there for days before they were removed. Mischievous children are apt to pick up and destroy these empty bottles by throwing them about. Carelessness on the part of the dairy in collecting the empties should not serve as an excuse for individuals to deliberately mishandle these bottles, but I believe where such conditions prevail, the milk dealers must assume some of the responsibility for any breakage. They should know that empty containers, if available, are desirable and convenient missiles in gang warfares and for street loungers or mischievous children to throw about. But in the main, householders are responsible for this great loss and for the fact that on the average, a milk bottle makes but twenty-five trips.

Fiber Containers

Fiber or cardboard containers as receptacles for milk are in use in some localities, but they have not been universally adopted for retail household trade. Until all milk dealers will co-operate and introduce a tried and satisfactory fiber bottle as

the service container for milk, then and only then will we have them in general use.

In the long run, fiber bottles will mean a container cheaper in price. Plants can have their own machines for making the fiber bottles, and all that is required is the purchasing of fiber paper as much as is needed. The fiber bottles are usually dipped into hot melted paraffin, the latter operation sterilizing the inside of the container and leaving therein a protective coat of paraffin. These containers do away with breakage, washing and the sterilization of bottles; no need for the collection of empties, and a corresponding reduction in hauling, etc.; less space is required in storage, shipping, and on delivery wagons, etc.; it is a non-conductor of heat; and it is possible to employ the outside of the container for advertising purposes.

The objections raised are that the cream line is not visible, and the presence of dirt is not easily detected. Some containers may impart a flavor from the cardboard; and if they are roughly handled, the fiber bottles may be broken or the paraffin coating may crack, yielding particles of paraffin in the milk. It is also said to be more difficult to handle such containers. It is possible to solve the latter two problems so that fiber containers will not be objectionable. In the case of the first-mentioned objection, the presence of dirt is not to be considered seriously with our present methods of inspection and laboratory control to guide us. The invisibility of cream line may be a blessing in disguise, for too many pasteurizing plants today heat the milk only to 142 degrees Fahrenheit, or not over 143 degrees Fahrenheit, for if 145 degrees Fahrenheit is employed, which temperature should be used at all times when pasteurization is conducted, they are fearful that the cream column might be reduced, resulting later in complaints from the consumer that the product is not as rich as a competitor's milk. Weighing the pros and cons, there is no doubt one must conclude that an improved properly constructed fiber bottle will solve the important problem as to the most convenient, most sanitary, cheapest and best method of supplying milk for the market.

Community Cooperation

We have considered the program practiced which is necessary for a solution of our national milk-control problem. It is pasteurization and inspection which has made milk and milk products wholesome and safe. It is un-

fortunate that in European countries, methods of inspection and even pasteurization are not adequate to be assured that a pure product is being supplied.

The methods employed by inspections and the necessity of pasteurization have been given, and laboratory control techniques will be discussed. But unless the people in a community do their share, they might just as well realize that the milk they actually consume may not be safe milk. The consumer is entitled to a clean wholesome milk, which we will assume (for in most instances such is the case today) is supplied to him. Unless the milk delivered to the householder is kept cold (below 50 degrees Fahrenheit), covered at all times, and placed in a clean closed receptacle (if not in a bottle), this liquid food will become quickly unfit for use. Housekeepers should be sure that their ice chests or refrigerators are not faulty, for the air present in the inside of the latter may not register 50 degrees Fahrenheit. Poor families without the convenience of refrigeration should order their daily supply at the corner milk store (which keeps the milk cold), and they should preferably obtain their supply in quantities as will be used at one meal or at one time, unless the weather is cold and a box on the outside or a window box can be used as a temporary refrigerator.

Milk delivered direct to the consumer in most eastern cities is generally left on the doorstep during the early morning hours usually between 3 A. M. and 7 A. M. This milk should not be left on the outside, especially if the weather is warm or if the sun may reach it. It should be placed in the refrigerator or in a cool place as soon as possible after delivery. Other than an increase in the total bacterial content which will result in bottled milk exposed to sunlight, recent investigations reported by the dairy division of the California Agricultural College revealed that the characteristic flavor of fresh milk is affected by exposure to sunlight. If for one of several reasons it may be impossible for the consumer to place the milk in a cold environment within four hours after delivery, it would then be advisable to have an insulated box or other device located on the outside in a sheltered place away from the sun or on the porch or shed. This may serve as a receptacle for the milk. In those cities where the two-trip delivery system is in practice, arrangements may be made to purchase the necessary supply on the trip most convenient to the purchaser. Whatever practice may be instituted, the thought in mind is that the milk consumer must care for the milk which is delivered to him, if

he desires to have this liquid food remain in a wholesome and safe condition as he received it. It is also advisable not to mix old milk with new milk, and not to leave milk of any kind in open containers and in warm places. The question of milk remaining good is the housekeeper's problem after it reaches the home; and unless there is a more general co-operation along these lines by consumers, the latter may have no one to blame but themselves if their milk becomes unfit for human consumption.

Laboratory Testing of Milk

To control the quality and purity of milk, testing of the latter is essential. The earliest methods employed were physical tests, this consisting of cream gauges in which the milk was allowed to stand, and the layer of cream rising to the surface was observed. These were followed by methods of determining the weight or specific gravity (using hydrometers adapted for milk and known specifically as lactometers), churn tests, and other more complicated chemical methods for the determination of the fat content, then tests for determining the total solid content, followed by procedures which reported the bacterial counts. In 1890, Dr. S. M. Babcock, of the Wisconsin Agricultural Experiment Station, devised a simple method which by means of centrifugal force and the addition of a single reagent, concentrated sulphuric acid, to a definite amount of the sample and these placed in a specially constructed long-necked bottle with graduations at proper intervals on their calibrated necks made it possible for one to determine quickly and effectively the fat content in milk. It is possible to read off directly the percentage of fat in the neck of the bottle. This simple and fairly accurate method, known as the Babcock test, and which is still in use today, revolutionized the milk industry and marked an epoch in the history of milk control. Its far-reaching importance in controlling the composition of milk was quickly recognized and this was adopted by the milk industry, thus enabling buyers to base their prices on the percentage of fat present. There is probably no test or invention in existence today which has not been altered or changed in itself during four decades of service and which has done so much to change and develop so great an industry. It is of interest to note that Professor Babcock received in October of last year the Capper prize of $5000 and a gold medal awarded for the most distinguished service to American agriculture. This prize was given him for his forty-year-old invention, which in

the words of former Governor Heard of Wisconsin "has made more dairymen honest than the Bible has ever made."

Today in the enforcement of milk regulations, bacterial, chemical and physical tests are conducted, usually in accordance with accepted standards introduced by the American Public Health Association and the Association of Official Agricultural Chemists. Milk as it arrives from the farms, before it is clarified or strained, is given the "visible dirt" test, known also as the "sediment" test. Pint samples of milk are well agitated and strained through cotton disks placed over openings one inch in diameter, present in any one of several types of apparatus. These cotton pledgets are carefully dried, and they are compared with gauges which as standards representing lots of milk filtered through them with 0, 5, 10, 15 and 20 milligrams of dry stable dirt. Samples containing more than one and one-quarter milligrams of dirt per pint are rated as dirty milk. Dirt of any description, regardless of the bacterial count, is objectionable, and its presence in milk or any foodstuff is sufficient to condemn such product as objectionable or even unfit for human consumption. Clean milk is possible without the necessity of straining, filtering or clarifying the raw material. This visible dirt test with the proper sanitary inspection aimed toward the obtaining of greater cleanliness in the handling of the milk will aid in securing a clean liquid food. The reductase or methylene blue reduction test is at times employed as an aid in milk control, especially where other laboratory facilities and trained help are not available. The test can be performed by any intelligent individual with very little expense and labor, and affords a means of rapid inspection of large numbers of milk samples to determine approximately the quality of these samples. This test depends upon the decolorization of a blue dye (methylene blue) in varying time intervals by the reducing bacteria which may be present in the milk. The greater the contamination of the sample, the quicker the decolorization—very bad milk causes decolorization in twenty minutes or less; milk of fair quality produces decolorization in less than five and one-half hours, but not less than two hours; and good milk causes no decolorization (the solution remains blue) in five and a half hours.

Laboratory facilities are necessary for more detailed tests. Techniques of performing bacterial examinations by what is known as the plate and microscopical methods are available. These tests are of considerable value from a public health standpoint. In the plate

method, it is possible to determine approximately by bacteriological procedures the number of bacteria present. In the direct microscopic examination there is available a means in the hands of a careful and experienced worker of obtaining quickly and at a very small cost an estimation of the bacterial content. These bacterial contents reveal a relationship to the sanitary conditions and care in the handling of the milk on the farm, to the care exercised in proper refrigeration during transportation, to the efficiency of pasteurization, to the handling and proper storage in the milk plant, and as a check on the promptness of delivery or in the proper care which milk dealers observe in the handling of the milk they offer for sale. Bacterial standards are an important factor in classifying milk according to different degrees of sanitary quality. Bacterial methods in milk examinations, more so than any other single test, afford the best procedure of determining and improving the sanitary character of public milk supplies.

Chemical tests of milk are conducted to see that the sample comes up to standard, or that the food value has not been impaired by adulteration. This gives protection against possible fraud. The tests which are generally and most frequently performed are the determination of the specific gravity by the use of a lactometer, the Babcock method of ascertaining the fat content, the detection of skimming or watering and the absence of preservatives and coloring matter (both of which are prohibited by law).

Throughout all stages of milk production, the senses of sight, taste and smell are employed to detect undesirable appearances, flavors and odors. Abnormalities in color, generally of rare occurrence in market milk, are readily detected and their causes are usually quickly determined. Similarly abnormalities in gross appearance, as coagulation, etc., are of infrequent occurrence and easy to detect and remedy. Abnormal flavors and odors may be more difficult to find, for frequently the sample of milk does not develop an objectionable flavor until twenty or more hours have elapsed or after the milk is heated as during pasteurization. Abnormal flavors and odors may be due to the spoilage of the milk (due to bacterial contamination), the physical condition of the cow, the feeding of highly flavored feeds or weeds, odors absorbed during the milking, or by exposure of milk during its various manipulations preparatory to marketing, and a metallic taste due to the heated milk coming in contact with equip-

ment during pasteurization in which copper, copper alloys or similar metal may have been exposed.

Methods for the detection of milk obtained from cows having mastitis or garget have been introduced. These tests have their limitations, but they are of value in detecting infected or suspicious cows, before their milk is mixed with normal samples, and the mixture reveals the abnormality after laboratory tests are conducted. Simple tests as straining some of the fore-milk through a fine mesh wire strainer, or stripping some of the fore-milk and running the latter through a black cloth, or the thybromol test (a simple, spectacular color observation), or more elaborate microscopical tests are employed.

Other tests are also used at times with the thought of affording a means to be assured of the quality of the milk, but the methods previously given are those most frequently conducted.

The Grading of Milk.

Milk grading is a method adopted by several cities, other communities and by some states as a means of classifying milk into several different types according to its quality and purity. It is a means of designating the varying degrees of desirability of this liquid as a food product. The grading of milk enables the consumer to select the quality he desires, paying for it in proportion to its chemical content and food value and freedom of contamination; it enables the milk dealer to select and pay for milk in proportion to its richness in fat and low bacterial content; and it enables the health authorities to control with greater ease and efficiency the sanitary and chemical quality of milk.

The grading systems of market milk in use throughout the country are so planned that even the lowest grade is one which is safe for human consumption. It is, however, unfortunate that there is no uniformity in these systems of grading as practiced in different localities. Standards for Grade A as required in one city may not be identical with the standards for Grade A milk as required in another city. The same holds true for the other grades, and in few instances one may find that the grade as listed in one city might even be comparable to a different grade in another city. There is not only a variation in the different requirements for various grades but there exists a variation in the number of grades allowed. This has resulted in misunderstandings and even confusion, and what has been said

under "milk ordinances" concerning Federal or State control or programs of unification apply here as well.

With all its attending difficulties today, a milk grading system is nevertheless desirable, providing that the health authorities are in a position to assume the numerous responsibilities made necessary by such a system. Graded milk is produced under the rigid supervision of the health department, a milk commission, or some similar authoritative body. Unless the latter is in a position to exact proper enforcement of its grading regulations by means of careful inspections and laboratory control, such a system should not be advocated or instituted. An unworkable or improperly enforced milk grading system will result in an injustice and harm to all parties concerned.

In the present grading systems in use, there are included only a few distinct and clearly defined grades, depending upon the cows employed, the sanitary conditions observed in the marketing of such milk, the chemical and bacterial contents of the end product and whether pasteurization was employed. Consumers in most large communities purchase milk on the basis of such grades, which in the case of individual containers appear on each bottle cap or conspicuously on other containers. In most cases the following grades are recognized or known:

Certified and Grade "A" Raw Milk.
Grade "A" Pasteurized Milk.
Grade "B" Pasteurized Milk.

In few communities Grade "C," for cooking purposes only, is allowed.

Certified Milk

In 1893 the first dairy producing "certified milk" was established as the direct result of efforts of the New Jersey Medical Society in their movement to encourage the marketing of a high-grade raw milk, specially adapted for infant feeding. The certified dairies, and almost 150 of them are in existence today in our country, are under the direct supervision of the state or municipal health authorities or a milk commission selected jointly by the latter and the pediatric or the county medical societies in the different communities. So that there may be uniformity in these regulations, the American Association of Medical Milk Commissions adopted and introduced in 1912 official methods and standards for the production and distribution of certified milk. The standard milk

ordinance and code recommended by the United States Health Service for adoption by all cities (1929) recognize certified milk conforming with the current requirements specified by this last named association, the offices of which are at 360 Park Place, Brooklyn, New York. The rules promulgated by them comprise ninety-seven regulations concerning complete details of dairy sanitation, tuberculin testing and veterinary supervision of the herd, milking and the care of this raw milk, chemical and bacteriological standards and methods, including tests to determine whether the milk was fraudulently heated or pasteurized, health and personal hygiene of the milkers and other employees, and methods of refrigeration and transportation.

The standards for certified milk are that it shall come from tuberculin tested cows, is not heated or pasteurized, shall conform with all requirements of the milk commission, and shall contain 4 per cent. fat (with a permissible range of variation of from 3.5 to 4.5 per cent.); and 3.5 per cent. protein (with a permissible range of from 3 to 4 per cent.); shall be free from adulteration, coloring matter and preservatives, and shall contain less than 10,000 bacteria per cubic centimeter of sample when delivered.

Grade "A" Raw Milk Requirements

The requirements for this grade are the same as for "certified milk," except that the permissible bacterial content is not more than 30,000 bacteria per c. c. of milk prior to or when delivered; and delivery as with the former grade should be made within thirty-six hours after collection.

Grade "A" Pasteurized

This is grade "A" raw milk which has been pasteurized, cooled and bottled. Requirements not only as to the sanitation of the farm, etc., as previously mentioned must be observed, but the milk plant where pasteurization and bottling are performed must conform to specific sanitary regulations. Grade "A" pasteurized milk may contain before heating 100,000 bacteria per c. c., but the average bacterial count after pasteurization and until delivery shall not exceed 50,000 per c. c.

Grade "B" Pasteurized

Grade "B" may contain as high as a million or even a million and a half bacteria per c. c. when raw, but must be pasteurized, and shall not contain over 100,000 bacteria per c. c. after pasteurization and until delivered. All other sanitary regulations as observed under grade "A" pasteurized are carried out here, with the exception that the cows may not have

been tuberculin tested and periodic health examinations of all farm employees are not compulsory.

Grade "C" Pasteurized

This is not a market milk to be used as delivered for human consumption. It is to be employed for cooking purposes solely, and where used it is generally sold in bulk to large buyers. All milk not capable of meeting the requirements of grade "A" and grade "B" pasteurized are grouped here. Even though used for cooking purposes solely, grade "C" must be pasteurized before it is delivered. No limit is placed upon the bacterial content, but this must be within reason.

Grades Commonly Used

The higher grades are used more frequently in larger communities, and the observation of the author has been that most farmers and milk operators consider it a duty to co-operate with public health authorities and to avoid unfair and illegal practices. The bacterial and even chemical standards as required by the milk commission or health board are not only met by them, but in most instances are even bettered, and milk dealers in general have heartily co-operated to raise and maintain high standards which are within reason.

It must be remembered however that not all communities can be expected to have their milk supplies meet the tuberculin testing and other standard requirements of grade "A" pasteurized milk. An immediate insistence upon the latter throughout all parts of our country would result in the possible discontinuance of the sale of milk in certain localities, where the conditions on the farms and the available facilities of transporting this perishable food are not as is observable and possible as in areas more favorably located. It is for this reason that "B" grades are allowed, until such time that all communities will have attained a status as is found today in all large cities.

Milk From Other Animals

Mention should be made that other lactating animals produce milk which is used in varying amounts by man in different parts of the world. Goat's milk is employed in mountainous areas where cows are not to be found. Some clinicians claim that this milk is better adapted than cow's milk for infant feeding, because it produces smaller and more flocculent curds which are more rapidly digested. Ass's and mare's milk have been employed at times. Ass's milk is very low in fat but otherwise closely approximates human milk, and it is more rapidly and more

easily digested. Among the other animals producing milk and which has been used by man, especially in Oriental countries, are: tamed buffaloes, camels, llamas, sheep, sows, whales, yaks and the zebus. In frigid countries, reindeer milk is employed at times by adult eskimos. This is the only animal milk having low water (68 per cent.) and lactose (2 per cent.) contents, and such high ash (1.5 per cent.), protein (10.5 per cent.) and fat (17 per cent.) contents.

THUMB-NAIL SKETCHES—1

By Hampton J. Hoch*

AMONG the numerous eminent men connected with pharmacy and medicine in South Carolina during the eighteenth century, John Lining stands forth singularly as a pioneer in experimental science. Born in Scotland in 1708 he had studied medicine at Edinburgh before emigrating to Charleston. The exact date of his arrival is not known, but it was probably shortly before 1730, for in January of that year his name was affixed to a legal paper.

The *South Carolina Gazette* of February 23, 1734, carries the following advertisement: "To be sold by John Lining in Broad Street, Citron Water at 7 per Gallon, Cinnamon Water at 4 per Gallon, Spirit of Wine at 3 10s. per Gallon, Annisseed,—Orange,—and Clove-Waters, Treacle Water and Ratafia." The fact that he does not prefix "Doctor" to his name leads us to infer that, although versed in medicine and undoubtedly an apothecary, he held no medical degree; contemporary advertisements of his fellow practitioners uniformly bear the title which was at that time very loosely bestowed.

Lining must early have won the esteem of his fellow-townsmen, for in 1738 he was an officer of Solomon's Lodge of Freemasons, in 1747 a quarantine officer (along with several other "practitioners of Physick"), in 1750 president of the Charleston Library Society.

Of a scientific and inquiring frame of mind, he recorded observations on the climate of Charleston during the years 1738-1742. These were published in the Transactions of the Royal Society of London in 1743 and procured for him a large portion of fame in Europe. Lining's meteorological observations were the first in South Carolina, and as far as we know the earliest in the American Colonies. The first to introduce an electrical apparatus into the province, he made extensive statical experiments and as one of the pioneers in the then novel subject of electricity he corresponded (1751) with Benjamin Franklin.

Advertisements continued to appear in the *Gazette* as late as August, 1748, when Lining informed the public that he sold Stoughton's Bitters and Treacle Water, each for 25s. per quart. A short time after this he entered into partnership with Dr. Lionel Chalmers, but perhaps he paid more attention to his experiments than to their

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joint business enterprise for we find the partnership dissolved in February of 1754. The debts owing them were apparently slow coming in because six years later the *Gazette* is still calling for debts due to the partnership.

In the field of medicine Lining's accurate history of the yellow fever, published in Charleston in 1753, was the first given to the world from the American Colonies. In the light of subsequent controversies it is interesting to note that he believed this disorder affected the system but once and that it was infectious rather than contagious.

On June 28, 1739, John Lining had married Sarah Hill, a daughter of former Chief Justice of South Carolina, Charles Hill. Four of their children died in infancy or early childhood, two sons and two daughters surviving.

Six years after forming a new partnership with Dr. David Oliphant and four years after being appointed an assistant judge, this versatile apothecary passed away, on September 14, 1760. Reckoned one of Charleston's most skilful practitioners, his fame was much more extensive than his practice. "He ranked high among the literati of the new world; he died with a distinguished reputation as a physician and a philosopher, after he had extended the literary fame of his adopted country to distant regions."

MEDICAL AND PHARMACEUTICAL NOTES

Alcohol Made From Crude Petroleum—Ethyl alcohol made commercially from ethylene gas is one of the most noteworthy changes in the chemical industry of this country, during the past year, Dr. James Doran, Commissioner of Industrial Alcohol, testified before the House Appropriations Committee when the Treasury Department appropriation bill was under consideration.

"This process was experimental the last time I appeared before the committee," Dr. Doran stated, "but the Union Carbide Company, through a subsidiary corporation, has succeeded in placing that production on a sound commercial basis, so that last year about 8,000,000 gallons of industrial alcohol were produced from crude oil through the cracking process and separation of ethylene gas and chemical treatment of the gas to produce ethyl alcohol.

"The expense of that process as compared with the old process is evidently sufficiently low to enable the company to compete with alcohol made from blackstrap molasses or grain. They are running the plant steadily. It is located at Charleston, West Virginia."

Dr. Doran said that the first experimental work on producing alcohol in this fashion was conducted during the war in Europe, and that Germany had attempted to do something with it from time to time, but that the Charleston, W. Va., plant was the first really large-scale operation in the world, "where it is being produced in quantity and as a steady and going process."

The Dangers of Obesity "Cures"—"The majority of so-called 'fat-reducers' offered for sale contain either thyroid extract or laxative drugs," said Dr. F. J. Cullen, chief of the Federal Food and Drug Administration's drug control unit, in a recently issued warning against the indiscriminate use of obesity "cures." "Thyroid extract is a dangerous drug and should be used only under the direction of a physician. This extract may cause a loss of weight in individuals who are suffering from a certain disease affecting the thyroid gland. These persons, however, should be treated and observed by a doctor."

Doctor Cullen stated that products containing laxative drugs and a poisonous drug, polk root (commonly known as "poke" weed) will cause a loss of weight in some people, due to their cathartic effects and the irritation caused in the stomach and intestines. This irritation has a tendency to lessen the absorption of food from the intestinal tract and also to decrease the appetite. If these preparations are used for a short time, Dr. Cullen explained, the appetite will increase and weight will be regained on discontinuance of the preparation. "Fat reducers," however, may be used over a considerable period of time and thus cause a chronic inflammation of the stomach and bowel and bring about permanent harm to the user.

SYNTHETIC RUBBER—The stages by which the new artificial rubber of the E. I. duPont de Nemours & Company was discovered and perfected, were revealed recently by Dr. W. H. Carothers to the fourth organic chemistry symposium of the American Chemical Society.

Synthetic rubbers are derived mostly from a group of simpler substances, liquid hydrocarbon oils known as "dienes," Dr. Carothers explained. On being allowed to stand these compounds react slowly with themselves to form substances resembling rubber.

In the case of isoprene, commonest of the dienes, which is obtained by decomposing natural rubber itself, this conversion to a rubber-like product is very slow and difficult to control, Dr. Carothers said. Hence the limited success reached in trying to commercialize this process.

Other dienes were prepared and studied by a group of duPont chemists including Dr. Arnold M. Collins, Ira Williams, Dr. Gerard J. Berchet, and Dr. James E. Kirby besides Dr. Carothers. Special attention was paid to the reactions of the dienes prepared from vinylacetylene, a compound formed by the joining of two molecules of the common gas acetylene.

Success crowned these efforts in the discovery of two dienes, chloroprene and bromoprene, having the desired behavior, continued Dr. Carothers. These compounds are very similar to isoprene; in them chlorine or bromine replaces the methyl group of the isoprene molecule. These react with themselves very rapidly to form rubber-

like products and thus permit the systemic study and control of the effect of different conditions on the transformation.

The work of Prof. J. A. Nieuwland, of the University of Notre Dame, and of W. S. Calcott, F. B. Downing and Dr. A. S. Carter, of the duPont Company, on the polymers of acetylene, all contributed to make this achievement possible

This fact of rapid reaction, Dr. Carothers stated, led to the new synthetic chloroprene rubber, DuPrene, which for certain special purposes is superior to the natural product.—(*Science Service.*)

NEWS ITEMS AND PERSONAL NOTES

Founders' Day Celebrated at Philadelphia College of Pharmacy and Science—The one hundred and eleventh anniversary of the founding of the Philadelphia College of Pharmacy and Science was celebrated there February 23 with a special convocation in the afternoon, followed by an alumni reunion in the auditorium in the evening.

At the convocation in the afternoon, Dr. C. Leonard O'Connell, associate dean of the University of Pittsburgh College of Pharmacy received the degree of Master of Pharmacy, *honoris causa.* As speaker of the afternoon, he delivered a masterful and forceful address upon the standards of education in pharmacy, stressing the fact that the training received by students in the four-year courses in pharmacy not only qualifies them professionally but also contains most of the elements of a college education in the liberal arts.

The afternoon convocation was also the occasion of the presentation to the college by H. K. Mulford, 1887, founder of the H. K. Mulford Company, of the fifth in the series of murals depicting the progress of pharmacy, which are hung in the foyer of the Philadelphia College. In a moving address at the dedication, Mr. Mulford made the presentation in memory of his two famed preceptors—Joseph P. Remington, 1866, long dean of the Philadelphia College, and Lucius E. Sayre, also 1866, at one time a business partner with Joseph P. Remington, and later dean of the University of Kansas School of Pharmacy.

Informal entertainment was the feature of the evening program attended by more than 500 alumni and senior students and by several distinguished guests. Among these were W. Bruce Philip, president of the American Pharmaceutical Association, and Mrs. Philip; Henry Brown, president of the Pennsylvania Pharmaceutical Association; Jennings B. Pilchard, its secretary; Dr. John C. Krantz, Jr., chief of the Maryland Bureau of Chemistry, and Dr. E. G. Eberle, editor of the *Journal of the American Pharmaceutical Association.*

One feature of the evening program was choral singing by the Pharmasingers, women students' singing society, under the leadership of Mrs. Charles H. LaWall, 1904.

The men students' glee club, under the direction of Dr. Adley B. Nichols, 1917, also sang numbers which were enthusiastically encored.

A minstrel show and a one-act drama by the students' dramatic society concluded the evening's special entertainment. The dramatic society play was written by Registrar John E. Kramer, 1925, and directed by Elsie Klenke, graduate student in pharmacognosy.

The director of the minstrel show was Lee G. Cordier, 1921. Ralph L. Calvert, also 1921 and a fellow faculty member, assisted him along with John Cooke, 1928, and Eugene R. Catteau, 1929. Five members of the senior class, Charles E. Anthony, Harry H. Arch, Donald Deibler, Ray Loos, and R. D. Jackson completed the cast.

Brief addresses were made by President Millicent R. LaWall of the Alumni Association and President Wilmer Krusen of the Philadelphia College. The entire evening program was under the direction of Joseph W. E. Harrisson, 1917, a member of the instructional corps and also a consulting chemist in Philadelphia.

Iodine Dental Therapy—An exhaustive study of the subject of Iodine Therapy by the internationally known authority, Dr. Hermann Prinz, has just been published by the Iodine Educational Bureau. This study contains a complete history of iodine, which was discovered in 1811 by the French chemist, Bernard Courtois, and information regarding its preparation, properties and its medical and particularly its dental uses, including a comprehensive formulary.

In preparing the manuscript for this treatise, Dr. Prinz has combined his life study of iodine with an exhaustive search of the subject in Europe, and with laboratory reports of work done by Appleton and Miller.

The treatise which, according to J. J. Nichols, director of the Iodine Educational Bureau, contains one of the most comprehensive studies on the subject of iodine thus far presented, has been prepared primarily to collaborate with professional men as to the diverse uses of iodine in its numerous compounds.

As a handbook for the practitioner and the dental student, the treatise "Iodine Therapy as Applied to the Practice of Clinical Dentistry," by Prinz, should prove of very great assistance. Pharmacists, physicians and dentists or dental students who have not received one of these booklets are invited to write to the Iodine Educational Bureau, Inc., at 120 Broadway, New York City, for a copy.

Bibliography of Bibliographies on Chemistry and Chemical Technology—The National Research Council announces the publication of Bulletin 86, which is the second supplement to the Bibliography of Bibliographies on Chemistry and Chemical Technology covering the period 1929-1931. The original Bulletin (No. 50) covered the period 1900-1924 and contained about 10,000 bibliographies classified under 2400 headings. The first supplement (No. 71) covered the period 1924-1928 and contained about 4000 bibliographies under 1050 headings. The second supplement (No. 86) covers the period 1929-1931 and contains approximately 3300 bibliographies under 950 headings.

As the title indicates, the work (as in the case of Bulletins Nos. 50 and 71) is a compilation of bibliographies published as separates, or at the end of books or magazine articles, or as footnotes to the same, on the numerous aspects of pure and applied chemistry. Each entry gives name of author or compiler, title, and place of publication. The majority of the entries state the number of references, thus giving an indication of the completeness of the particular bibliography. The entries are classified under the proper subject headings, alphabetically arranged. The duplication of individual entries has been largely avoided by the liberal use of cross references.

As an example of the value of this compilation, the following information is given regarding the number of bibliographies reported in Bulletin No. 86 for some of the more important topics:

Biochemistry, 32; Blood Chemistry, 75; Carbohydrates, 29; Ceramics, 18; Coal, 16; Colloids, 30; Cement and Concrete, 35; Fats, 33; Fertilizers, 34; Foods and Feedingstuff, 49; Hormones, 31; Iron and Steel, 90; Metabolism, 72; Milk, 44; Paper, 35; Petroleum, 65; Plant Chemistry, 39 Rubber, 35; Soils, 76; Vitamins, 41; Water, 33.

These bulletins may be obtained from the publication office, National Research Council, Washington, D. C., at the following prices: No. 50, \$2.50; No. 71, \$1.50; No. 86, \$1.50. Special price on complete set ordered at one time (no discount to dealers), \$4.

BOOK REVIEWS

THE STRUCTURE AND COMPOSITION OF FOODS. By Andrew L. Winton, Ph. D., and Kate Barber Winton, Ph. D. Volume I, Cereals, Starch, Oil Seeds, Nuts, Oils, Forage Plants; with 274 illustrations by the authors. John Wiley & Sons, Inc., New York. Price, $8.50.

The original "Winton," issued in 1906, was called "The Microscopy of Vegetable Foods," and was the work of Dr. A. L. Winton with the collaboration of Dr. Josef Moeller of the University of Graz. It has filled a place in the field of American works on the microscopy of foods which no other single book had ever done and it has made itself an indispensable adjunct to the work of the consulting food chemist and chemist in charge of food law enforcement. It is with great pleasure, therefore, that the first volume of the new and augmented work is welcomed.

With the added data concerning chemical composition the work has increased materially in its practical value to the laboratory worker, and when the entire series is issued, the three volumes will displace a whole shelf full of books which will be relegated to the section for works of historical or occasional reference value.

The descriptions are excellent, the drawings are as nearly perfect as illustrations can be, whether signed with the initials "A. L. W." or "K. B. W." The style is scholarly and painstaking and the work bears every evidence of exceedingly careful preparation, both as to selection and arrangement of subject matter.

A thirty-five-page index, with heavy faced figures denoting the more important references, adds materially to the value of the book, as do also the numerous references to the original sources of information for various kinds of data.

The scientific or technical laboratory that attempts to get along without this book will find itself severely handicapped. It is not only a valuable book, but it is indispensable.

CHARLES H. LAWALL.

THE ILLUSTRATED APOTHECARIES' CALENDAR FOR 1932.

This, the seventh annual publication of "Der Illustrieter Apotheker-Kalender," bears, as usual, a preface by Dr. Fritz Ferchl, the talented compiler of this useful and interesting work. The source of material from which he has drawn his illustrations seems to be inexhaustible as to numbers, and as for variety, there seems to be scarcely any limit.

The list of illustrations this year comprises the following fields or groups: laboratories, stores, shelf bottles, mortars, wrought iron decorations, paintings of Christ as an apothecary, diplomas and certificates, portraits, interior views of pharmacies, symbolic pictures, apparatus, distillation, frontispieces and title pages, pharmacists' signs and memorial coins.

One of the finest of the plates is that of a bas relief of Gregor Mendel, the discoverer of the laws of heredity, who died in 1884, nearly a generation before the value of his work was recognized.

Another interesting plate is that showing the sixty-four items selected for the portable chemical laboratory suggested by J. J. Becher in 1680.

Still another of more than passing interest is the banner of the Faculty of Pharmacy of the University of Padua, which celebrated its seven hundredth anniversary just a decade ago, in 1922.

Those who have an opportunity to glance over the calendar will be surprised to see the manner in which Abraham was prevented from sacrificing his beloved son, Isaac, by angelic intervention, as portrayed on the walls of a seventeenth century Jesuit apothecary shop. A written description cannot do justice to it, nor to the seventeenth century conception of the source of amber and the manner of its collection. Seeing is believing—sometimes.

The yearly arrival of this calendar is a welcome addition to the literature and culture of the profession. May the series continue for many years is the hope of American friends of professional pharmacy.

CHARLES H. LAWALL.